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Математическое моделирование акустических колебаний химически реагирующей двухфазной смеси монодисперсных твердых частиц в газообразном окислителе

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Аннотация. ***Введение.*** Явление самовозбуждения акустических колебаний за счёт теплообмена известно давно, но его изучение началось недавно из-за развития высокофорсированных камер сгорания. Эти колебания могут дестабилизировать горение, но также могут быть полезны, увеличивая тепловую нагрузку и сокращая время сгорания. Исследование волновых режимов горения важно, как теоретически, так и практически. В большинстве случаев изучали гомогенные среды, но реальные системы, такие как «жидкие капли – окислитель» или «твёрдые частицы – окислитель», демонстрируют уникальную волновую динамику. Для понимания этих процессов и управления колебаниями необходимо более глубокое изучение. ***Цель.*** На основе модели взаимодействующих континуумов рассмотрена задача о слабонелинейных волновых возмущениях в ограниченном объёме химически реагирующей двухфазной смеси монодисперсных твердых частиц в газообразном окислителе. Исследование учитывает, что динамическое и тепловое взаимодействие фаз влияет на диссипацию и дисперсию фазовой скорости звука. Метод медленно меняющихся амплитуд позволил свести систему уравнений сохранения массы, энергии и импульса к нелинейному волновому уравнению. Получены уравнения для установившихся амплитуд колебаний. Обсуждено влияние дисперсии, вызванной различием температур и скоростей фаз, на нелинейное взаимодействие стоячих волн. Показано, что зависимость скорости звука от частоты ограничивает перекачку энергии вверх по спектру, увеличивая амплитуды первых обертонов. ***Материалы и методы.*** С помощью метода медленно меняющихся амплитуд система уравнений сохранения массы, энергии и импульса для обеих фаз сведена к единственному нелинейному волновому уравнению. ***Результаты и обсуждение.*** Получены уравнения для определения значений установившихся амплитуд колебаний. Исследовано влияние дисперсии, вызванной несовпадением температур и скоростей фаз газовзвеси, на нелинейное взаимодействие стоячих волн. ***Заключение.*** В данной статье представлено исследование поведения акустических возмущений в ограниченном объёме горящей газовзвеси.

Целью исследования было получение единственного нелинейного волнового уравнения, описывающего эволюцию давления в топке. В основу анализа положено предположение о малости влияния нелинейности, дисперсии и неконсервативности колебаний на амплитуды волн. Это позволило применить метод разложения решения по собственным модам линейной консервативной задачи для решения полученного уравнения. Процедура разложения позволила свести исходное волновое уравнение к бесконечной системе обыкновенных дифференциальных уравнений для комплексных амплитуд. В рамках этого подхода были найдены значения установившихся амплитуд стоячих волн, что представляет собой важный вклад в понимание динамических процессов в системах горения. Таким образом, исследование демонстрирует высокую степень аналитической строгости и математической точности, а также глубокое понимание фундаментальных принципов акустики и горения. Полученные результаты могут быть использованы для дальнейшего развития теоретических моделей и экспериментальных исследований в области горения и акустических процессов.

Ключевые слова: вибрационное горение, акустические колебания, волновые режимы, химически реагирующая газовзвесь

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Research article

Mathematical modeling of acoustic oscillations of chemically reacting two-phase mixture of monodisperse solid particles in a gaseous oxidant

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Abstract. ***Introduction.*** The phenomenon of self-excitation of acoustic oscillations due to heat transfer has been known for a long time, but its study has only recently begun due to the development of high-pressure combustion chambers. These oscillations can destabilize combustion, but they can also be beneficial by increasing the heat load and reducing the combustion time. The study of wave modes in combustion is important both theoretically and practically. Most studies have focused on homogeneous media, but real systems such as "liquid droplets-oxidizer" or "solid particles-oxidizer" exhibit unique wave dynamics. A deeper understanding is needed to comprehend these processes and manage fluctuations. ***Goal.*** Based on the model of interacting continua, the problem of weakly nonlinear wave disturbances in a limited volume of a chemically reacting two-phase mixture of monodisperse solid particles in a gaseous oxidant is considered. The study takes into account that the dynamic and thermal interaction of the phases affects the dissipation and dispersion of the phase sound velocity. The method of slowly changing amplitudes allowed the system of mass, energy, and momentum conservation equations to be reduced to a nonlinear wave equation. Equations for the steady-state amplitudes of oscillations were obtained. The effect of dispersion caused by the difference in temperatures and phase velocities on the nonlinear interaction of standing waves is discussed. It is shown that the dependence of the speed of sound on frequency limits the transfer of energy up the spectrum, increasing the amplitudes of the first overtones. ***Materials and methods.*** Using the method of slowly varying amplitudes, the system of mass,

energy, and momentum conservation equations for both phases is reduced to a single nonlinear wave equation. ***Results and discussion.*** Equations are obtained for determining the values of the established amplitudes of oscillations. The influence of dispersion caused by the non-coincidence of temperatures and velocities of gas-suspension phases on the nonlinear interaction of standing waves is investigated. ***Conclusion.*** This article presents a study of the behavior of acoustic disturbances in a limited volume of burning gas suspension. The goal of the study was to obtain a single nonlinear wave equation that describes the evolution of pressure in the furnace. The analysis is based on the assumption that the effects of nonlinearity, dispersion, and non-conservation of oscillations on wave amplitudes are negligible. This assumption allows us to use the method of decomposition of the solution into eigenmodes of the linear conservative problem to solve the obtained equation. The decomposition procedure reduces the original wave equation to an infinite system of ordinary differential equations for complex amplitudes. Within this approach, the values of the steady-state amplitudes of the standing waves were found, which represents an important contribution to the understanding of the dynamic processes in combustion systems. Thus, the study demonstrates a high degree of analytical rigor and mathematical accuracy, as well as a deep understanding of the fundamental principles.

Key words: vibration combustion, acoustic oscillations, wave modes, chemically reacting gas suspension
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Introduction. The effect of excitation and amplification of acoustic vibrations due to heat removal has been known for a long time (for example, the phenomenon of "singing flames" and the Rijke tube [1], in which heat is supplied to the air using a hot grid). However, interest in the self-excitation of sound waves by means of combustion arose relatively recently in connection with the creation of highly accelerated furnaces and combustion chambers of rocket engines, in which strong pressure fluctuations were discovered [1-5]. These vibrations can significantly disrupt the combustion process and lead to the destruction of the structural elements of the furnace or engine. On the other hand, it often turns out to be advantageous to maintain an oscillatory combustion mode [6-8], since this increases the thermal stress of the furnaces, significantly intensifies the processes of heat and mass transfer and, as a result, reduces the combustion time of the fuel. In addition, the transition to vibrational combustion opens up great prospects in metallurgy, the chemical industry, etc. [1]. Thus, the problem of wave modes of behavior of reacting systems is of not only theoretical but also practical interest. Basically problem of the theory of vibrational combustion was considered in relation to homogeneous media (with the exception of [9, 10]). In real systems, burning systems are mixtures of the "liquid droplets - oxidizer" or "solid particles - oxidizer" type, whose wave dynamics differ from those in homogeneous media. For example, heat and mass transfer processes lead to the dissipation of sound wave energy in inert systems and can amplify waves in reacting two-phase systems.

In this paper, the problem of weakly nonlinear wave disturbances in a confined volume of a chemically reacting two-phase mixture of monodisperse solid particles in a gaseous oxidizer is considered using a model of interacting interpenetrating continua. The study corresponds to a situation where the dynamic and thermal interaction between the phases determines not only the dissipation of sound wave energy but also the dispersion of the phase velocity of sound. Using the method of slowly varying amplitudes, the system of equations for the conservation of mass, energy, and momentum for both phases is reduced to a single nonlinear wave equation. Equations are derived for determining the values of steady-state oscillation amplitudes. The influence of dispersion caused by the mismatch of temperatures and phase velocities of the gas

suspension on the nonlinear interaction of standing waves is discussed in detail. It is shown that the dependence of the speed of sound on frequency leads to a limitation of energy transfer up the spectrum and, thereby, to an increase in the amplitudes of the first overtones.

Materials and methods of the study. We will consider the acoustic vibrations of a mixture consisting of solid particles reacting in a kinetic regime, suspended in a gaseous oxidizer. For simplicity, we will assume that the particles have identical thermophysical properties. Assuming that there are a sufficient number of particles at distances of the order of the wavelength, we will describe the oscillation processes in the system using methods of continuum mechanics. We will assume that the chemical reaction occurs in a purely heterogeneous regime without changing the molar content, for example $C + O_2 \to CO_2$. It is known that the combustion reaction of carbon is significantly more complex [11]. However, taking into account intermediate reactions would significantly complicate the analysis and lead to more complex calculations, but at the same time would not significantly affect the effects considered here. Neglecting the dissipation of sound waves due to viscosity and thermal conductivity in the gas volume, we write the system of equations of motion of a two-phase mixture in the form:

$$\frac{\partial(\varepsilon d_0)}{\partial t} + \frac{\partial(\varepsilon d_0 u)}{\partial x} = -I;\ \frac{\partial(\rho d_1)}{\partial t} + \frac{\partial(\rho d_1 v)}{\partial x} = I;$$

$$\frac{\partial(\varepsilon n_0)}{\partial t} + \frac{\partial(\varepsilon n_0 u)}{\partial x} = -I_0;\ \rho = 1-\varepsilon,\ d_0 = n_0 + n_1;$$

$$\varepsilon d_0\left(\frac{\partial}{\partial t} + u\frac{\partial}{\partial x}\right)u = -\frac{\partial p}{\partial x} - f + I(u-v);$$

$$\rho d_1\left(\frac{\partial}{\partial t} + v\frac{\partial}{\partial x}\right)v = f;\ p = R_0 n_0 T + R_1 n_1 T_0; \quad (1)$$

$$\varepsilon d_0 c_v\left(\frac{\partial}{\partial t} + u\frac{\partial}{\partial x}\right)T_0 + p\frac{\partial}{\partial x}(\varepsilon u + \rho v) =$$

$$= Q_0 - \alpha(T_0 - T_e) - \frac{p}{d_0}I\left(1 - \frac{d_0}{d_1}\right) + f(u-v) - I\frac{(v-u)^2}{2};$$

$$I = -(g-1)I_0;\ \rho d_1 c_1\left(\frac{\partial}{\partial t} + v\frac{\partial}{\partial x}\right)T_1 = -Q_1;\ Q_0 - Q_1 = LI_0.$$

Here p, T_0, is the average pressure and temperature of the mixture of the oxidizer and reaction product, T_e is the ambient temperature, α is the effective heat transfer coefficient, d_0, d_1 and u, v are the densities and average velocities of the carrier gas and particles, respectively, ρ is the volume concentration of the particles, n_0 and n_1 are the densities of the oxidizer and reaction product, T_1 is the average temperature of the particles, L is the heat of reaction, g is the ratio of the molecular weights of the reaction product and the oxidizer, c_v is the specific heat capacity of the gas at constant volume, c_1 is the specific heat capacity of the material of the particles.

A stationary state, in which the suspension is considered motionless $(u = v = 0)$, is achieved when the heat release due to the chemical reaction is equal to the heat removal through the channel walls, $LI_0 = \alpha(T_0 - T_e)$ i.e.

When analyzing the wave motions of a two-phase reacting mixture, the system of equations (1) can be closed by the following expressions for the heat fluxes $Q_0, Q_{1,}$, the oxidizer flux I_0, and the interphase interaction force f:

$$f = \frac{\rho d_1}{\tau_d}(u - v);\ \tau_d = \frac{2a^2 d_1}{9\nu_0 d_0}$$

$$Q_0' = \frac{3\rho\lambda_0}{a^2}(T_1' - T_0');\ \frac{dT_1'}{dt} = \frac{T_0' - (1 - p_*)T_1'}{\tau_t} \quad (2)$$

$$I_0' = \frac{3\rho\lambda_0 p_*}{a^2 L} T_1';\ p_* = \frac{E}{RT_{01}}(T_{01} - T_0);\ \tau_t = \frac{a^2 d_1 c_1}{3\lambda_0},$$

where the prime denotes the quantities disturbed by the wave, λ_0 is the thermal conductivity coefficient of the carrier gas, T_{01} is the stationary temperature distribution in the vicinity of the particle, E is the activation energy, R is the gas constant, T_0', T_1' is the disturbance of the temperature in the gas and inside the particle, respectively, by the sound wave, a is the particle radius, ν_0 is the kinematic viscosity of the mixture of the oxidizer and the reaction product, τ_d is the relaxation time of the phase velocities in the Stokes flow around the particle. Expressions (2) were obtained for a highly dilute gas suspension ($\rho << 1$) for the case of quasi-stationary flow around the particles. The latter is valid in a situation where the wave frequency satisfies the inequality

$$\tau_d'\omega \sim \tau_t'\omega << 1,\ \tau_d' = \frac{a^2}{\nu_0},\ \tau_t' = \frac{a^2}{\chi_0},$$

where τ_d' and τ_t' - relaxation times for the processes of establishing a quasi-stationary distribution of velocity and temperature in the vicinity of a particle, χ_0 - thermal diffusivity of the gas phase.

We will further assume that the oxidizer density n_0 does not change over a time of the order of the wave period, i.e. $\tau_n\omega >> 1$. Here $\tau_n = \frac{a^2(1+x)}{3\rho Dx}$, , and is x a parameter characterizing the ratio of the rate of chemical reaction to the rate of oxidizer supply to the particle surface through diffusion. For the kinetic combustion regime

$$x = \frac{az\exp\left(-\frac{E}{RT_0}\right)}{D}$$

much less than one, where z is the pre-exponential factor, D is the diffusion coefficient.

Research results and discussion. The behavior of acoustic vibrations in an inert or chemically reacting gas suspension depends on the processes of dynamic and thermal interaction between the phases. These phenomena cause dissipation of wave energy and dispersion of its phase velocity. Note that the influence of heat and momentum exchange has the strongest impact on the propagation of acoustic waves under the condition $\tau_d\omega \sim \tau_t\omega \sim 1$.

Let us assume that the times of heating of the gas $\tau_к$ by the heat of chemical reaction and mass transfer τ_j satisfy the following inequalities $(p_* << 1)$

$$\tau_j \omega > \tau_k \omega \to \infty,$$

where

$$\tau_k = \frac{a^2 d_0 c_v (1-p_*)}{3\rho\lambda_0 p_*},\ \tau_j = \frac{a^2 L d_0 (1-p_*)}{3\rho\lambda_0 (g-1) T_0 p_*}.$$

Characteristic times $\tau_к$ and τ_t are related to each other by the ratio

$$\tau_t = p_* (1-p_*)^{-1} \Lambda_t \tau_k,\ \Lambda_t = \rho \frac{d_1 c_1}{d_0 c_v}.$$

The dispersion relation corresponding to the linearized system (1), (2) has the form

$$(kc_0)^2 = \omega^2 \gamma (1 + \Lambda_d - i\tau_d \omega)(1 - i\tau_d \omega)^{-1} B(\omega), \quad (3)$$

$$c_0^2 = \gamma R T_0, \quad \gamma = \frac{c_p}{c_v}, \quad \Lambda_d = \rho \frac{d_1}{d_0},$$

where k is the wave number (in general, complex), ω is the real frequency, c_0 – the "frozen" speed of sound. For the kinetic regime of a chemical reaction

$$B = \left[1 + (\Lambda_t - i\tau_t \omega)(1-p_*)^{-1} + \frac{1}{i\tau_к \omega}\right]\left[\gamma + \frac{\Lambda_t - i\gamma\tau_t \omega}{1-p_*} + \frac{1}{i\tau_к \omega}\right]^{-1} \quad (4)$$

We will restrict ourselves to a quadratic approximation, i.e., in the equations describing the motion of a two-phase mixture (1), we will retain only the linear and quadratic terms for the disturbances. Although the expressions for the interphase interaction force and heat fluxes (2) are obtained in a linear approximation, they can be used in the analysis of nonlinear wave processes, based on the following considerations. We will consider waves of finite amplitude, whose profile varies slightly over distances on the order of a wavelength. This variation is caused by the nonlinearity in the conservation and state equations and the nonconservative nature of the interphase interaction. If these processes are considered to have an equal effect on the wave, then including nonlinear terms in the above expressions would mean exceeding the accepted accuracy.

Denoting the quantities in a stationary gas suspension by the accepted symbols, and their perturbations in a wave by the same symbols with a prime, from (1) and (2) we obtain, with an accuracy of up to quantities of the second order of smallness in perturbations, the following system of equations

$$\frac{\partial d_0'}{dt} + d_0\left[\frac{\partial u'}{\partial x} + \rho \frac{\partial}{\partial x}\left(v' - u'\right)\right] + \frac{\partial\left(d_0' u'\right)}{\partial x} = 0 \quad ;$$

$$\left(d_0 + d_0'\right)\frac{\partial u'}{\partial t} + d_0 u' \frac{\partial u'}{\partial x} + \left(\rho d_1 + \rho' d_1\right)\frac{\partial v'}{\partial t} + \rho d_1 v' \frac{\partial v'}{\partial x} =$$

$$= -R \frac{\partial}{\partial x}\left(T_0 d_0' + d_0 T_0' + d_0 T_0'\right);$$

$$\left(d_0 + d_0^{/}\right)\frac{\partial T_0^{/}}{\partial t} + d_0 u^{/}\frac{\partial T_0^{/}}{\partial x} - (\gamma - 1)\left[\left(T_0 + T_0^{/}\right)\frac{\partial d_0^{/}}{\partial t} + T_0 u^{/}\frac{\partial d_0}{\partial x}\right] = (5)$$

$$= \frac{3\rho\lambda_0}{a^2 c_v}\left(T_1^{/} - T_0^{/}\right) + \frac{\rho d_1}{\tau_d c_v}(u - v)^2;$$

$$\frac{\partial v^{/}}{\partial t} + v^{/}\frac{\partial v^{/}}{\partial x} = \frac{u^{/} - v^{/}}{\tau_d} \quad ;$$

$$\frac{\partial T_1^{/}}{\partial t} + v^{/}\frac{\partial T_1^{/}}{\partial x} = \frac{T_0^{/} - (1 - p_*)T_1^{/}}{\tau_t}.$$

The linearized system of equations (1) and (2) allows for unstable periodic solutions, with instability occurring when moving from high to low frequencies. Including quadratic terms in (5) leads to a transfer of energy from low-frequency oscillations upwards in the spectrum. Thus, the combined influence of nonlinearity and nonconservatism can lead to the existence of a stationary solution for system (5).

Let us consider the behavior of longitudinal acoustic vibrations in a confined heat-generating incandescent tube of length *l*. In such a system, the formation and establishment of finite-amplitude standing waves is possible due to reflection from the boundary and the superposition of perturbations traveling toward each other. However, studying the evolution of an arbitrary perturbation directly from system (5) is quite difficult. Therefore, it makes sense to reduce this system to a single evolution equation. Considering a highly dilute mixture $(\rho << 1)$, we rewrite equation (5) in dimensionless form. The first three equations in (5) will be:

$$\frac{\partial d^*}{\partial \tau} + \frac{\partial u^*}{\partial y} + \frac{\partial\left(d^* u^*\right)}{\partial y} = 0;$$

$$\frac{\partial u^*}{\partial \tau} + d^*\frac{\partial u^*}{\partial \tau} + u^*\frac{\partial u^*}{\partial y} + \Lambda_d\frac{\partial v^*}{\partial \tau} = -\frac{\partial p^*}{\partial y}; \quad (6)$$

$$\frac{\partial T^*}{\partial \tau} + u^*\frac{\partial T^*}{\partial y} + d^*\frac{\partial T^*}{\partial \tau} - (\gamma - 1)\frac{\partial d^*}{\partial \tau} - (\gamma - 1)T^*\frac{\partial d^*}{\partial \tau} - (\gamma - 1)u^*\frac{\partial d^*}{dy} = \Lambda_t\sigma_t\left(T_1^* - T^*\right).$$

The following dimensionless variables and parameters are introduced here

$$u^* = \frac{u'}{c_*},\ p^* = \frac{(1 + \Lambda_t)(1 + \Lambda_d)}{\gamma + \Lambda_t}\frac{p'}{p},\ \tau = \frac{c_* t}{\ell},$$

$$y = \frac{x}{\ell},\ d^* = \frac{d'}{d_0},\ T^* = \frac{T'}{T_0},\ T_1^* = \frac{T_1'}{T_0},$$

$$v^* = \frac{v'}{c_*},\ \Lambda_d = \frac{\rho d_1}{d_0},\ \Lambda_t = \rho\frac{d_1 c_1}{d_0 c_v},\ \gamma = \frac{c_1}{c_v}$$

It is easy to see that the terms in equations (6) containing the variables v^* и T^* have second-order smallness in perturbations. Therefore, in the remaining equations (5), it is sufficient to retain only the linear terms:

$$\frac{\partial v^*}{\partial \tau} = \sigma_d \left(u^* - v^*\right) \quad ; \quad \sigma_d = \frac{\ell}{c_* \tau_d} \quad (7)$$

$$\frac{\partial T_1^*}{\partial \tau} = \sigma_t \left(T^* - T_1^* (1 - p_*)\right); \quad \sigma_t = \frac{\ell}{c_* \tau_t}.$$

Based on the linearized system (6), we have differential relationships between pressure and velocity disturbances

$$\frac{\partial u^*}{\partial \tau} = -\frac{\partial p^*}{\partial y} \quad ; \quad \frac{\partial p^*}{\partial \tau} = -\frac{\partial u^*}{\partial y} \quad , \quad (8)$$

as well as expressions relating perturbations of pressure, density and temperature

$$d^* = p^* = \frac{1}{\gamma - 1} T^* \quad . (9)$$

Using the integral relations following from (7)

$$v^* = \sigma_d e^{-\sigma_d \tau} \int_0^\tau e^{\sigma_d \tau} u^* d\tau \quad ;$$

$$T_1^* = \sigma_t e^{-\sigma_t (1 - p_*)\tau} \int_0^\tau e^{\sigma_t (1 - p_*)\tau} T^* d\tau \quad ,$$

and also (8) and (9), within the accepted accuracy, we transform system (6) to the form

$$\frac{\partial p^*}{\partial \tau} + \frac{\partial u^*}{\partial y} = \frac{1}{2}(\gamma - 1)\frac{\partial \left(p^*\right)^2}{\partial \tau} + \frac{1}{2}\frac{\partial \left(u^*\right)^2}{\partial \tau} - \Lambda_t \sigma_t p^* + \Lambda_t \sigma_t^2 e^{-\sigma_t (1 - p_*)\tau} \int_0^\tau e^{\sigma_t (1 - p_*)\tau} p^* d\tau$$

(10)

$$\frac{\partial u^*}{\partial \tau} + \frac{\partial p^*}{\partial y} = \frac{1}{2}\frac{\partial \left(p^*\right)^2}{\partial y} - \frac{1}{2}\frac{\partial \left(u^*\right)^2}{\partial y} - \Lambda_d \sigma_d u^* + \Lambda_d \sigma_d^2 e^{-\sigma_d \tau} \int_0^\tau e^{\sigma_d \tau} u^* d\tau$$

Differentiating the first equation (10) with respect to τ, and the second with respect to y, and subtracting the second result from the first, we obtain a single nonlinear wave equation for the pressure in the furnace

$$\frac{\partial^2 p^*}{\partial \tau^2} - \frac{\partial^2 p^*}{\partial y^2} = \frac{1}{2}\left[(\gamma - 1)\frac{\partial^2 \left(p^*\right)^2}{\partial \tau^2} + \frac{\partial^2 (u^*)^2}{\partial \tau^2} + \frac{\partial^2 \left(u^*\right)^2}{\partial y^2} - \frac{\partial^2 (p^*)^2}{\partial y^2}\right] + (11)$$

$$+ \alpha_1 p^* - \alpha_2 \frac{\partial p^*}{\partial \tau} - \alpha_3 e^{-\sigma_t (1 - p_*)\tau} \int_0^\tau e^{\sigma_t (1 - p_*)\tau} p_* d\tau + \alpha_4 e^{-\sigma_d \tau} \int_0^\tau e^{\sigma_d \tau} \frac{\partial p^*}{\partial \tau} d\tau \quad ,$$

where $\alpha_1 = \Lambda_t \sigma_t^2$, $\alpha_2 = \Lambda_t \sigma_t + \Lambda_d \sigma_d$,

$$\alpha_3 = \Lambda_t \sigma_t^3 (1 - p_*) \quad , \quad \alpha_4 = \Lambda_d \sigma_d^2 .$$

The left-hand side of (11) is the standard wave-level operator, the right-hand side consists of nonlinear square terms and terms describing energy pumping, its dissipation, and distributed

dispersion effects. The latter also have second-order smallness in perturbations due to the fact that the coefficients $\alpha_i << 1$, i = 1, 2, 3, 4.

For a linear conservative system, instead of (11) we have the usual wave equation

$$\frac{\partial^2 p^*}{\partial \tau^2} - \frac{\partial^2 p^*}{\partial y^2} = 0 \quad (12)$$

The solution of this equation in a limited volume can be represented as a sum of standing waves

$$p^* = \sum_{n=-\infty}^{\infty} \Phi_n e^{-i\omega_n \tau} \cos(\kappa_{|n|} y + \varphi_{|n|}) \quad ,$$

$$\Phi_n^* = \Phi_{-n} \quad , \quad -\omega_n = \omega_{-n} \quad , \quad \omega_n^2 = k_n^2 \quad ,$$

where Φ_n - arbitrary amplitude, ω_n - natural frequency of mode with number n , φ_n - phase.

It was shown above that the terms on the right-hand side of equation (11) are significantly smaller than those on the left-hand side. Therefore, we will seek a solution to equation (11) as a series in terms of the eigenmodes of the generating linear conservative equation, assuming that, as a result of nonlinear interaction, dissipation, and energy pumping, the amplitudes of the standing waves are slowly varying functions of time:

$$p^* = \sum_{n=-\infty}^{\infty} \Phi_n(\mu\tau) e^{-i\omega_n \tau} \cos(\kappa_{|n|} y + \varphi_{|n|}), \quad \mu << 1 \, , \quad (13)$$

$$u^* = i \sum_{n=-\infty}^{\infty} \mathrm{sign}(n) \Phi_n(\mu\tau) e^{-i\omega_n \tau} \sin(\kappa_{|n|} y + \varphi_{|n|}) \, .$$

Substituting expressions (13) into equation (11), we obtain

$$\sum_{n=1}^{\infty} \omega_n \left(\frac{dF_n}{d\tau} - (\gamma_n - i(\delta_n + \varepsilon_n)) F_n \right) e^{-i\omega_n \tau} \cos\chi_n = \quad (14)$$

$$= -\frac{1}{8} i\gamma \sum_{n=1}^{\infty} \sum_{m=1}^{\infty} \left[(\omega_m + \omega_n)^2 F_n F_m e^{-i(\omega_n + \omega_m)\tau} \cos(\chi_m + \chi_n) \right] +$$

$$+ (\omega_m - \omega_n)^2 F_m F_n^* e^{-i(\omega_m - \omega_n)\tau} \cos(\chi_m - \chi_n) \quad .$$

Here

$$\omega_n = \kappa_n = \pi n + \varepsilon_n \quad , \quad \chi_n = \pi n y + \psi_n \quad ,$$

$$\Psi_n = \varepsilon_n y + \varphi_n \quad , \quad F_n = \Phi_n e^{-i\varepsilon_n \tau} \quad ,$$

$$\gamma_n = \frac{1}{2} \left(\frac{\Lambda_t \sigma_t^3 (1 - p_*)}{\sigma_t^2 (1 - p_*)^2 + \omega_n^2} + \frac{\Lambda_d \sigma_d^3}{\sigma_d^2 + \omega_n^2} - \Lambda_d \sigma_d - \Lambda_t \sigma_t \right),$$

$$\delta_n = \frac{1}{2} \left(\frac{\Lambda_t \sigma_t^4 (1 - p_*)^2}{\omega_n \left(\sigma_t^2 (1 - p_*)^2 + \omega_n^2 \right)} - \frac{\Lambda_t \sigma_t^2}{\omega_n} - \frac{\Lambda_d \sigma_d^2 \omega_n}{\sigma_d^2 + \omega_n^2} \right).$$

We assume that the ends of the volume are close to acoustically closed, i.e. $|\varphi_n| << 1$ and $|\varepsilon_n| << 1$. Then equation (14) can be reduced to an infinite system of differential equations for complex amplitudes

$$\frac{dF_n}{d\tau} - (\gamma_n - i(\delta_n + \varepsilon_n))F_n = -\frac{i\gamma\pi n}{8}\left\{2\sum_{m=1}^{\infty} F_{m+n}F_m^* + \sum_{m=1}^{n} F_m F_{n-m}\right\} \quad ; \quad n = 1,2,3... \tag{15}$$

Let us introduce real amplitudes and phases into consideration, i.e., let us set $F_n = p_n e^{i\theta n}\ (n = 1,2,...)$, where p_n - amplitude, θ_n - phase. Separating the real and imaginary parts in (15), we obtain a system of equations describing the nonlinear interaction of standing waves in the quadratic approximation.

$$\frac{dp_n}{d\tau} = \gamma_n p_n + \frac{\gamma\pi n}{8}\left\{2\sum_{m=1}^{\infty} p_{n+m}p_m \sin(\theta_{m+n} - \theta_m - \theta_n) - \sum_{m=1}^{n} p_m p_{n-m} \sin(\theta_n - \theta_m - \theta_{n-m})\right\} \tag{16}$$

$$p_n \frac{d\theta_n}{d\tau} = -(\delta_n + \varepsilon_n)p_n - \frac{\gamma\pi n}{8}\left\{2\sum_{m=1}^{\infty} p_{n+m}p_m \cos(\theta_{m+n} - \theta_m - \theta_n) - \sum_{m=1}^{n} p_m p_{n-m} \cos(\theta_n - \theta_m - \theta_{n-m})\right\}$$

$$n = 1,2,...$$

Next, we restrict ourselves to the case of interaction of four vibration modes (n = 1, 2, 3, 4). A necessary condition for the existence of steady-state amplitudes of sound waves different from zero is the presence of at least one mode that decays according to the given approximation, i.e., in the set γ_n (n = 1, 2, ,3, 4) must contain quantities of different signs. Let us consider the case of a shallow entry into the instability region ($\gamma_1 > 0, \gamma_2 < 0, |\gamma_1| << 1$), when the amplitude of only the fundamental tone increases, while the remaining overtones are damped (since in real processes, high harmonics are characterized, all other things being equal, by increased energy dissipation). The stationary solution of equation (16) is found from a system of nonlinear algebraic equations for p_n and Δ_n

$$\gamma_n p_n + \frac{\gamma\pi n}{8}\left\{2\sum_{m=1}^{4-n} p_{n+m}p_m \sin\Delta_{mn} - \sum_{m=1}^{n} p_m p_{n-m} \sin\Delta_{(n-m)m}\right\} = 0$$

$$g_{\kappa+1} - g_k - g_1 = 0, \quad g_4 - 2g_2 = 0, \quad \kappa = 1,2,3.$$

Here

$$g_n = -(\delta_n + \varepsilon_n) - \frac{\gamma\pi n}{8}\left\{2\sum_{m=1}^{4-n} \frac{p_n + mp_m}{p_n} \sin\Delta_{mn} - \sum_{m=1}^{n} \frac{p_m p_{n-m}}{p_n} \sin\Delta_{(n-m)m}\right\} = 0 \quad ,$$

$$\Delta_\kappa = \theta_{k+1} - \theta_k - \theta_1 (k = 1,2,3) \quad , \quad \Delta_4 = \theta_4 - 2\theta_2 .$$

Using Seidel's method, we find the steady-state oscillation amplitudes with and without dispersion. Thus, dispersion, caused by the mismatch between the average temperatures and phase velocities of the gas suspension, leads to an increase in the amplitudes of the first overtones and a decrease in the amplitudes of subsequent harmonics. The latter is explained by the fact that the presence of dispersion in the system disrupts internal resonances and, consequently, limits the transfer of energy up the spectrum.

Conclusion. In this article, we have derived a single nonlinear wave equation describing the evolution of pressure in a furnace to study the behavior of acoustic disturbances in a confined volume of a burning gas suspension. The assumption that nonlinearity, dispersion, and nonconservative nature of the oscillations have a small effect on wave amplitudes allowed us to use the eigenmode expansion method for a linear conservative problem to solve the resulting equation. This procedure reduced the original wave equation to an infinite chain of ordinary differential equations for complex amplitudes. The steady-state amplitudes of the standing waves were determined.

Список источников

1. Раушенбах Б.В. Вибрационное горение. - М.: Физматгиз, 1961. - 500с.
2. Рогинский О.Г. О вибрационном горении. Обзор // Акустический журнал. – 1967. –Т.7, вып. 2. – С. 131-155.
3. Хзмалян Д.М., Каган Я.А. Теория горения и топочные устройства. – М.: Энергия, 1976 – 488 с.
4. Зельдович Я.Б., Баренблотт Г.И., Либрович В.Б., Махвиладзе Г.М. Математическая теория горения и взрыва. – М.: Наука, 1984. – 374 с.
5. Основы практической теории горения. Под ред. Померанцева В.В. - Л.: Энергоатомиздат , 1986. - 312с.
6. Аракелян Э.К., Янукян Э.Г. Горение полидисперсного топлива // Известия РАН. Энергетика. – Москва, 2002, №2.- С. 60-67.
7. Янукян Э.Г. Волновые режимы горения в конденсированных средах // Журнал «Обозрение прикладной и промышленной математики». – Москва, 2004, т.11, С. 130.
8. Yanukyan E. G. Computational modeling of controlled unsteady combustion for dispersed fuels // Book of abstracts of the Fifth World Congress on Computational Mechanics. - Vienna, Austria, 2002, Vol. 2. - P. 584.
9. Борисов А.А. Распространение возмущений в двухфазных химически реагирующих средах // Нелинейные волновые процессы в двухфазных средах.- ИТФ СОАН СССР. Новосибирск.- 1977.-с.128-142.
10. Борисов А.А., Вахгельт А.Ф. Эволюция волн в двухфазных химически реагирующих средах. – Деп. ВИНИТИ. №5576.-1984.-20с.
11. Хитрин Л.Н. Физика горения и взрыва. – М.: Изд-во МГУ, 1957. – 443с.

References

1. Raushenbakh B.V. Vibratsionnoe gorenie. - M.: Fizmatgiz, 1961. - 500s.
2. Roginskii O.G. O vibratsionnom gorenii. Obzor // Akusticheskii zhurnal. – 1967. –T.7, vyp. 2. – S. 131-155.
3. Khzmalyan D.M., Kagan YA.A. Teoriya goreniya i topochnye ustroistva. – M.: Ehnergiya, 1976 – 488 s.
4. Zel'dovich YA.B., Barenblott G.I., Librovich V.B., Makhviladze G.M. Matematicheskaya teoriya goreniya i vzryva. – M.: Nauka, 1984. – 374 s.
5. Osnovy prakticheskoi teorii goreniya. Pod red. Pomerantseva V.V. - L.: Ehnergoatomizdat , 1986. - 312s.
6. Arakelyan EH.K., Yanukyan EH.G. Gorenie polidispersnogo topliva // Izvestiya RAN. Ehnergetika. – Moskva, 2002, №2.- S. 60-67.
7. Yanukyan EH.G. Volnovye rezhimy goreniya v kondensirovannykh sredakh // Zhurnal «Obozrenie prikladnoi i promyshlennoi matematikI». – Moskva, 2004, t.11, S. 130.
8. Yanukyan E. G. Computational modeling of controlled unsteady combustion for dispersed fuels // Book of abstracts of the Fifth World Congress on Computational Mechanics. - Vienna, Austria, 2002, Vol. 2. - P. 584.
9. Borisov A.A. Rasprostranenie vozmushchenii v dvukhfaznykh khimicheski reagiruyushchikh sredakh // Nelineinye volnovye protsessy v dvukhfaznykh sredakh.- ITF SOAN SSSR. Novosibirsk.- 1977.-s.128-142.
10. Borisov A.A., Vakhgel't A.F. Ehvolyutsiya voln v dvukhfaznykh khimicheski reagiruyushchikh sredakh. – Dep. VINITI. №5576.-1984.-20s.
11. Khitrin L.N. Fizika goreniya i vzryva. – M.: Izd-vo MGU, 1957. – 443s.

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Микрополосковые антенны для бистатической радиолокационной системы, размещенной на БЛА

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Аннотация. ***Введение.*** Статья посвящена исследованию особенностей работы бистатической радиолокационной системы, установленной на беспилотном летательном аппарате, и обоснованию выбора оптимальной антенно-фидерной системы для неё. Подчёркнута важность учёта влияния корпуса беспилотного летательного аппарата, выполненного из токопроводящего материала, на характеристику направленности антенны и поляризацию излучаемых сигналов. Отмечено отсутствие в литературе достаточного количества информации и рекомендаций относительно подбора антенно-фидерной системы для бистатической радиолокационной системы, устанавливаемой на беспилотных летательных аппаратах, что определяет актуальность проводимого исследования. ***Цель.*** Цель работы состоит в разработке требований к выбору и расчёту, моделированию антенно-фидерной системы, удовлетворяющей условиям эксплуатации в составе бистатической радиолокационной системы. ***Материалы и методы.*** Представлены этапы разработки и тестирования выбранного решения, включающие определение технических требований к антенно-фидерной системе, оценка применимости известных конструкций антенн, расчёт и изготовление опытных образцов, проведение экспериментальных исследований. Для моделирования и оптимизации характеристик микрополосковых антенн использовался специализированный программный комплекс Antenna Designer пакета MATLAB. ***Результаты и обсуждение.*** По результатам проведённых исследований установлено, что использование микрополосковых антенн обеспечивает возможность создания однонаправленного излучения, стабильность электрических параметров в рабочем диапазоне частот и технологичность изготовления. Описаны конструктивные преимущества микрополосковых антенн, выявленные в ходе исследований. ***Заключение.*** Сделан вывод о целесообразности применения микрополосковых антенн для решаемых задач и предложено направление дальнейших исследований, связанное с созданием двухэлементных антенных решёток для повышения эффективности функционирования бистатической радиолокационной системы.

Ключевые слова: полосковая антенна, микрополосковая антенна, бистатическая радиолокационная система, зондирование земной поверхности, беспилотный летательный аппарат

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Microstrip antennas for a drone-mounted bistatic radar system

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Abstract. ***Introduction.*** This article examines the operational characteristics of a bistatic radar system installed on an unmanned aerial vehicle (UAV) and substantiates the selection of an optimal antenna-feeder system for it. The importance of considering the influence of the UAV body, made of conductive material, on the antenna directivity and polarization of emitted signals is emphasized. A lack of sufficient information and recommendations regarding the selection of an antenna-feeder system for a bistatic radar system installed on UAVs is noted, which determines the relevance of this study. ***Goal.*** The objective of this work is to develop requirements for the selection, calculation, and modeling of an antenna-feeder system that meets operating conditions within a bistatic radar system. ***Materials and methods.*** The stages of development and testing of the selected solution are presented, including determining the technical requirements for the antenna-feeder system, assessing the applicability of existing antenna designs, calculating and manufacturing prototypes, and conducting experimental studies. The specialized Antenna Designer software package in MATLAB was used to model and optimize the characteristics of microstrip antennas. ***Results and discussion.*** The results of the studies revealed that microstrip antennas provide unidirectional radiation, stable electrical parameters across the operating frequency range, and easy manufacturing. The design advantages of microstrip antennas identified during the studies are described. ***Conclusion.*** A conclusion is reached regarding the feasibility of using microstrip antennas for the tasks being solved, and a direction for further research related to the development of two-element antenna arrays to improve the efficiency of bistatic radar systems is proposed.

Key words: strip antenna, microstrip antenna, bistatic radar system, earth surface sensing, unmanned aerial vehicle

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Introduction. When implementing a bistatic (diversity) radar system (BRS) [1, 2], one of the primary challenges is selecting an antenna-feeder system (AFS), as the system's operation is sensitive to the antenna's radiation pattern (RP) and the polarization of the emitted wave. The antenna's RP shape is further distorted by the unmanned aerial vehicle (UAV) body, which is typically constructed from conductive materials to provide shielding for the electronic devices inside the UAV. Due to the nature of the research being conducted, the literature does not fully address the analysis and recommendations for selecting an AFS for BRS.

Thus, the decision on selection and calculation of the development of an AFU for UAVs, taking into account the specifics of their use in radar systems, is a pressing scientific challenge.

In this regard, the purpose of this article is to consider the operation of the radar from the point of view of the features of the radar system operation when placed on a UAV, the formation of requirements for the AFU, as well as the selection of the optimal design, calculations, modeling and study of the characteristics of the manufactured AFU for the radar.

Materials and research methods.

1. Formation of requirements for the AFU for the radar.

In a bistatic (diversity) radar system (BRS), two antenna systems with different functional purposes are used: transmitting and receiving (Fig. 1).

Requirements for antennas must be presented according to two groups of criteria:

1) required antenna characteristics and parameters;

2) required design, technological and operational features.

As a rule, the requirements for antennas in the first group are more important and decisive than the basic requirements for the parameters in the second group. In this case, the criteria of the second group are no less important than those of the first due to the specifics of antenna use onboard UAVs.

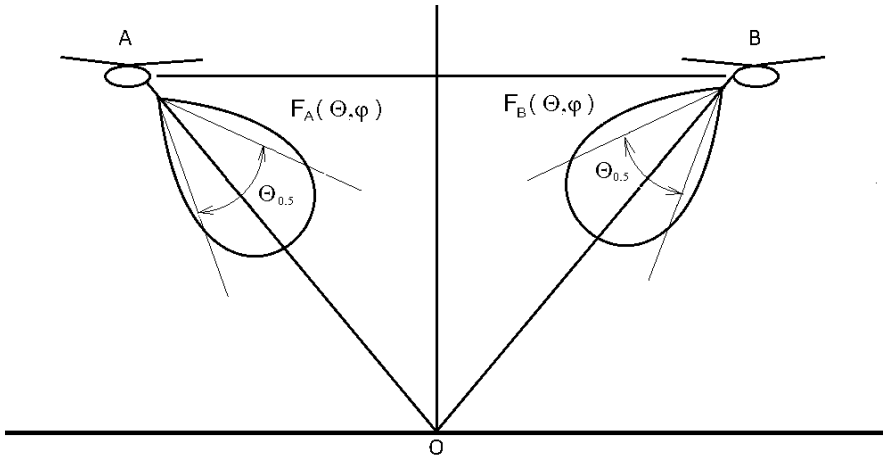


Figure 1 – To determine the requirements for antenna devices of a bistatic (diversity) radar system

Figure 1 shows that the problem being solved is geometrically symmetrical, and it makes no difference whether the radar transmitter and receiver are located at position A or B. This implies that the requirements for the radar transmitting and receiving antennas are identical. Antenna theory has proven that the fundamental electrodynamic parameters and characteristics of an antenna in transmitting and receiving modes are identical, so it is possible to use identical antennas for both receiving and transmitting in the bistatic radar system being developed [3, 4].

Requirements to antennas:

1) it is necessary to ensure radiation (reception) in a given sector of incidence (reflection) angles of 45...90 degrees with as uniform a dependence as possible on the angle of the directivity coefficient (DC) - i.e. to ensure a “sector” RP;

2) it is necessary to ensure horizontal and vertical polarization of the emitted (received) wave (for a transmitting antenna, simultaneous emission of waves of two polarizations is possible);

3) it is required that the antenna has acceptable matching (standing wave ratio (SWR) < 5 for transmitting and < 2 for receiving antennas) at a given operating frequency (in the frequency band).

So, of classes of medium-directional antennas with linear polarization, such as vibrator antennas, meet these requirements [4, 5].

2. Selecting the type of AFU for the radar

During the first stage of development, it was planned to use the standard vibrator antennas of the Stilsoft Skyron O UAV. For this purpose, studies were conducted on the

electrical and electrodynamic properties of the carbon fiber composite from which the UAV body is made.

The conductivity (resistance) of a carbon fiber body cover sample from one of the UAV prototypes was measured along the surface in various directions using a DC current using an electronic multirange ohmmeter. The measured resistance values ranged from several tens of ohms to a few kilohms (the lowest measured resistance was 76 ohms; the highest was 1987 ohms), with significant randomness observed. No dependence of the resistance on the preferred directions or the path length between the extreme points of the carbon fiber cover was observed.

The studies of the electrodynamic properties of carbon fiber were carried out in laboratory conditions at a measuring range using a TK -450 S transmitter emitting an unmodulated carrier at a frequency of 469 MHz and equipped with a standard shortened antenna (A 1), as well as an Anritsu spectrum analyzer S 362E in power measurement mode with a shortened dipole antenna (A 2) from the National laboratory kit Instruments on the receiving part of the radio line.

Before measuring the carbon fiber composite parameters, the measurement site was evaluated to obtain calibration curves due to its limited physical dimensions and the presence of interfering reflections. For this evaluation, the field strength generated by the transmitter was measured at various distances from the transmitting antenna. Field strength values were recorded using an Anritsu 326 E instrument in spectrum analyzer mode (Fig. 2). Two experiments were conducted sequentially:

1) measuring the passage of electromagnetic waves through (through) the carbon fiber fragment of the body of the Stilsoft Skyron O UAV;
2) measurement of the level of electromagnetic wave reflection from the surface of a fragment of the body of the Stilsoft Skyron O UAV.

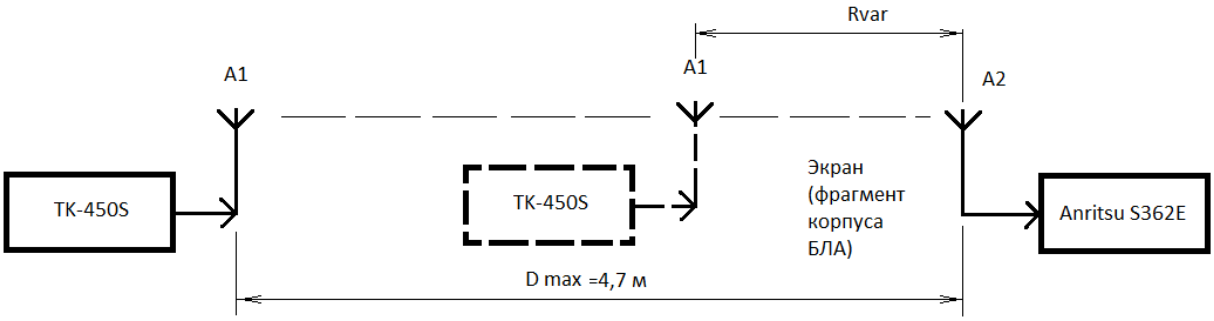


Figure 2 – Estimation of polygon error

Table 1 – Results of the experiment on studying the properties of carbon feeder

R , m	0.3	0.6	0.64	0.96	1.28	1.6	1.92	2.24
E_{free} , dB	-9.8	-10.1	-10.0	-9.8	-10.1	-10.0	-10.1	-9.9
E_{trans} , dB	-12.0	-13.0	-14.0	-10.7	-1 1 ,6	-10.1	-12.7	-11.7
E_{ref} , dB	-10.0	- 9.6	-12.0	-10.0	- 11,0	-9.8	-10.0	-9.1

Based on the measurement results, it was concluded that it is not possible to use antennas with a significant (commensurate with the level of the direct signal) level of rear and side radiation (for example, vibrator antennas) due to strong interference dips that will inevitably arise in the resulting RP (Fig. 3).

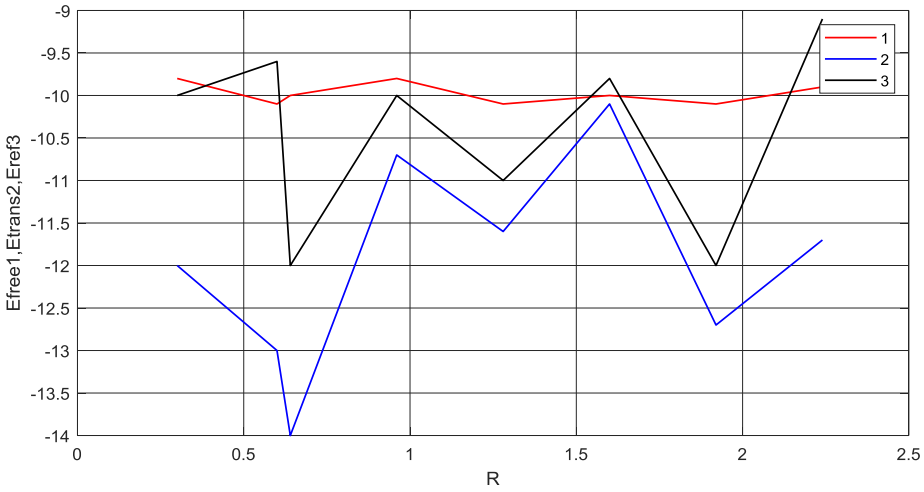


Figure 3 – Results of experiment studying the electrodynamic parameters of a carbon feeder casing: 1 – direct signal without a shield; 2 – transmission through a carbon feeder shield; 3 – reflection from a carbon feeder shield

To confirm this conclusion, the DD of an asymmetric (quarter-wave vibrator) vibrator antenna over a flat semiconducting screen with carbon fiber parameters was simulated using the MMANA program. GAL (Fig. 4).

For vertical polarization of the antenna in the vertical plane in the sector of angles of 45...89 degrees, the change (dips in the radiation pattern) amounted to $-15 \div -17$ dB relative to maximum.

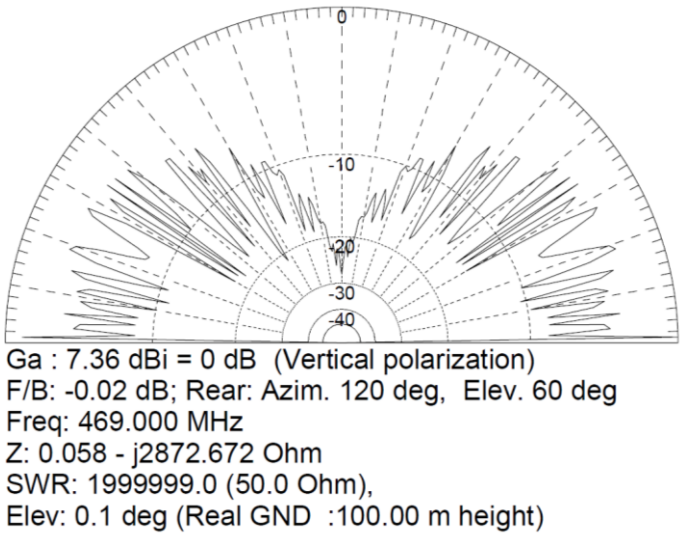


Figure 4 – The result of modeling a vibrator antenna over a semiconducting flat screen with carbon feeder parameters

Following the research, the use of the standard vibrator antennas of the Stilsoft Skyron O UAV had to be abandoned for the following reasons:

1) the dimensions of the standard antennas and the configuration of their placement do not allow obtaining acceptable directions of the main lobes of the radiation pattern and their width (Fig. 6);

2) the body and structural elements of the UAV are made of carbon fiber, which is a semi-conducting composite material with chaotically anisotropic electrodynamic parameters (

σ, ε_r); as a result of interference phenomena, the influence of the structural elements of the UAV on the RP becomes unpredictable;

3) the use of standard UAV antennas requires the integration of the radar into the UAV control system, which is impractical and highly undesirable due to the significant uncertainty and unpredictability of such a solution.

In the second stage, other antenna types with low backscatter radiation were investigated. The research showed that horn and reflector antennas, as low-backscatter antennas in the wavelength range used (0.6396 m), have unacceptably large longitudinal geometric dimensions. For traditional medium-directional antennas (vibrator, loop, etc.) with effective reflectors and screens (the screen dimensions must be equal to the operating $1,5 \div 2$ wavelength), the antenna system dimensions are also significant.

At the third stage, due to the fact that the antenna characteristics largely ensure the selection, calculation or setting of the characteristics and parameters of other functional parts of the radar (at least without knowing at least approximate values, it is impossible to set requirements for the required transmitter power and receiver sensitivity), a decision was made not to limit ourselves to general recommendations for choosing their type, but to develop a specific antenna for the radar.

The analysis showed the feasibility of choosing microstrip antennas, since significant achievements of recent decades in the field of microwave technology and microminiaturization have made it possible to develop efficient designs of such antennas manufactured using printed circuit board and integrated circuit technologies [6].

They are characterized by a simple design, small dimensions and weight, high manufacturability, good reproducibility of dimensions and electrical parameters, the ability to operate in dual- and multi-frequency modes, with linear and circular polarization, and with dual polarization. Stripline radiators are convenient as elements of antenna arrays (including conformal ones), and the use of printed technology significantly simplifies the implementation of various element power supply circuits, from the simplest series circuits to complex branched parallel circuits. The operating frequencies of stripline (SPA) and microstrip (MSPA) antennas and arrays range from hundreds of MHz to several tens of GHz [7, 8].

In addition, the MSPA are fundamentally shielded in the rear hemisphere of the RP, and the shielding effect is achieved with screen sizes significantly smaller than for other classes of antennas.

The main disadvantages of SPA and MSPA are low electrical strength, low permissible power of input oscillations; in the case of resonator-type antennas, narrowband (the relative operating frequency band is on average no more than 5%) [7, 8]. In the considered version of the bistatic radar system, these disadvantages are insignificant, since the required operating range does not exceed several meters, and narrowband signals are supposed to be used as probing radiation.

There are many strip and microstrip antennas, which can be conditionally classified into the following types [7, 8]:

– Vibrator antennas: with inductive and conductive excitation; loop vibrators; polyvibrator antennas;

– slot antennas: excited by strip and microstrip lines, with microstrip resonators; open ends of strip and microstrip lines;

– flat two-dimensional SPA and MSPA: resonant type; non-resonant type; with distributed connection to the power line;

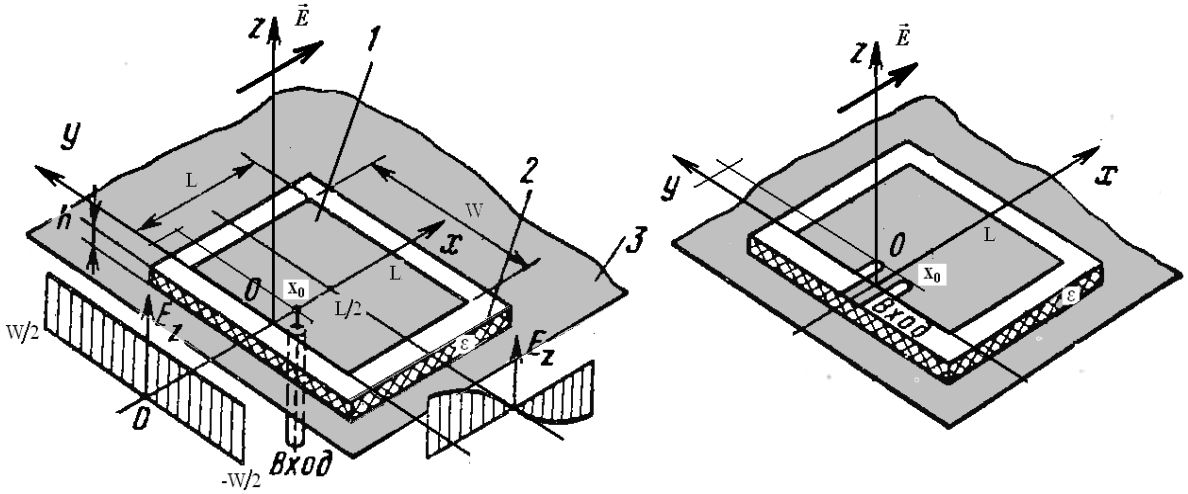
– volumetric (three-dimensional) SPA and MSPA;

– frequency-independent and multi-frequency SPA and MSPA: spiral, vibratory, log-periodic, etc.

The shape of stripline radiators is selected based on the required operating mode of the antenna, its frequency properties, the desired pattern shape, and the radiation polarization. In practice, rectangular, triangular, rhombic, elliptical, circular, and more complex radiator shapes—ring, circular sector, ring sector, etc.—are used [9].

3. Calculation of the microstrip antenna radiator

Printed strip antennas (PSA) of the resonant type based on rectangular radiators have become widely used as independent antennas and elements of antenna arrays [3, 7, 8]. PSAs of this type contain a radiator in the form of a rectangular metal strip 1, located on the outer surface of a dielectric substrate 2 above a metal screen 3 (Fig. 7) [7].



a) b)

Figure 5 – MSPA based on a rectangular resonator emitter with excitation by a coaxial line using a probe (a) and an asymmetric strip line (b)

Examples of excitation of resonant MSPAs are illustrated in Figure 5, a − using a coaxial transmission line and a probe; b − using an asymmetric strip line, the conductor of which is located on the surface of the substrate in the same plane as the emitter. Dielectrics with a relative permittivity and $\varepsilon = 2 \div 16$ a low dielectric loss tangent $tg\delta$ of no more than, are usually used as the substrate material $(1 \div 5) \cdot 10^{-3}$; the substrate thickness is $h \approx (0{,}01 \div 0{,}1)\lambda_0$ [10]. The antenna radiation is created by electric currents flowing along the surface of the plate and screen, as well as by bias currents in the dielectric substrate.

Typically, in such a structure, resonant electromagnetic oscillations of the lowest (fundamental) type are excited TM_{100}; the indices characterize the number of variations of the transverse wave in relation to the plane of the screen and the emitter components of the electric field strength vector E_z in the resonator cavity volume beneath the emitter along *the x* , *y,* and *z*

coordinate axes . The entire structure is considered a cavity resonator without side walls, thereby ensuring radiation into the surrounding space.

In rectangular PAs, the lowest type of resonance occurs at the emitter length

$$L \approx \lambda_л / 2 , \quad (1)$$

where $\lambda_л \approx \lambda_0 / \sqrt{\varepsilon_r}$ is the length of the quasi- T wave in a strip line with a strip line width W . Note that the field component along the axis y is distributed uniformly, and along the axis x in the longitudinal direction, it is distributed sinusoidally with antinodes at the edges of the emitter at $x = 0, L$ and zero at the center under the emitter $x = L / 2$ (Fig. 5).

At the resonant frequency, the antenna's input impedance becomes purely resistive and reaches values of several hundred ohms at the edges of the radiator parallel to the y-axis. Zero reactive input impedance facilitates matching of the radiator to the power line and ensures intense radiation.

To date, several methods have been developed for analyzing the characteristics of resonator SPAs, based on various mathematical models of the radiating structure [9]. In a rigorous formulation, the radiation problem is solved, for example, by the current method [11]. In this case, a boundary value problem is formulated and a system of integral equations is compiled for the scalar components of the vector distribution of the surface electric current density $J(z, y)$ on a conducting strip.

For a simplified approximate solution to the analysis problem, a simpler model is usually used, according to which the SPA is considered as a system of two equivalent slot radiators formed by the edges of a strip element (from one of which the exciting oscillations are supplied) and a screen. It is assumed that the radiation in the far zone is formed precisely by these slots, and radiation from the side slots is practically absent [12].

If the length of the emitter L is a multiple of an odd number of half-waves of the quasi- T wave, in particular, $L \approx \lambda_л / 2$, then the components of the field strength in slots 1 and 2 are out of phase (Fig. 5, a). The directions of the equivalent magnetic currents in the end slots and side slots are determined by the expression [8]

$$\cdot \quad \cdot \quad , \quad (2)$$

where $\vec{n}$ is the unit vector of the outer normal to the planes of the slits.

From (2) it follows that the equivalent magnetic currents of the end slots (open ends of the cavity resonator) are uniformly distributed and, most importantly, are in-phase. They generate maximum radiation in the direction normal to the screen plane, i.e., along the *z-axis*, with the far-field polarization of the vector parallel to the *x-axis* (Fig. 5). The equivalent magnetic currents in the side slots (parallel to the *x-axis*) are pairwise antiphase and contribute virtually nothing to the overall antenna radiation in the normal direction.

When the length of the strip radiator is a multiple of an even number of half-waves of the quasi-T wave, there is no radiation along the normal to the plane of the screen.

Directional pattern of the resonator MSPA within the upper hemisphere of space $(\theta = -90^\circ \ldots$ can be calculated with sufficient accuracy using the formula [13]

$$F(\theta,\varphi)=F(\theta)\cdot F(\varphi)=cos\theta\cdot cos\left(\frac{\pi L}{\lambda}sin\theta\right)\cdot\frac{sin\left(\frac{\pi W}{\lambda}sin\varphi\right)}{\frac{\pi W}{\lambda}sin\varphi}, \quad (3)$$

Where $F(\theta,\varphi),F(\theta),F(\varphi)$ – normalized radiation patterns: spatial, in planes θ and φ accordingly;

L,W – resonator dimensions MSPA according to Figure 5, a.

To calculate the radiation patterns, we used the Antenna Designer application from the Matlab package. The initial data for the calculation were: the operating frequency f (wavelength); the antenna patch dimensions; the angular coordinate (λ or) of one of the principal planes of the spherical coordinate system φ was used θ as a variable parameter. The second angular coordinate was fixed (Figs. 7, 8).

Radiation $F(\theta)$ patterns at $\varphi=0^{\circ}$ (blue color) and $F(\varphi)$ at $\theta=90^{\circ}$ (red color) are shown in Figure 6.

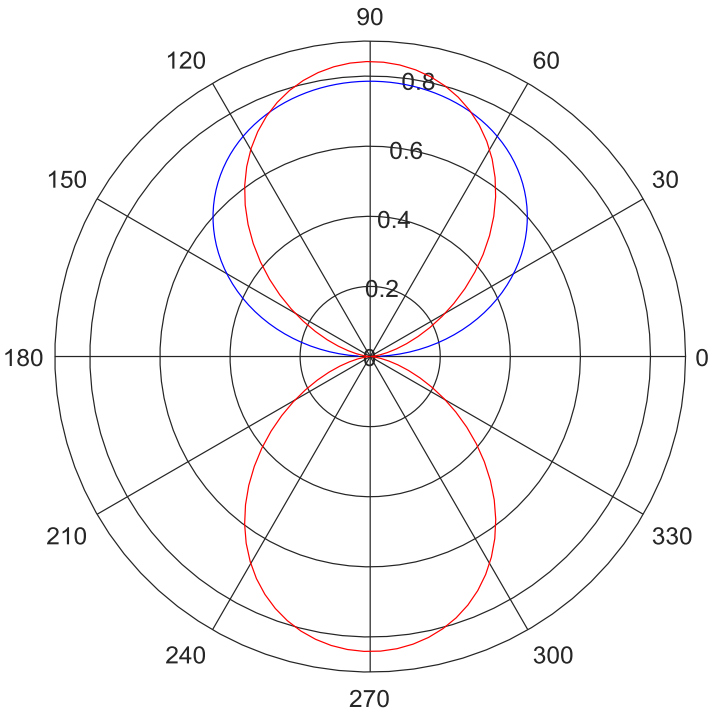


Figure 6 – MSPA RP graphs : calculation using formula (3) in Matlab

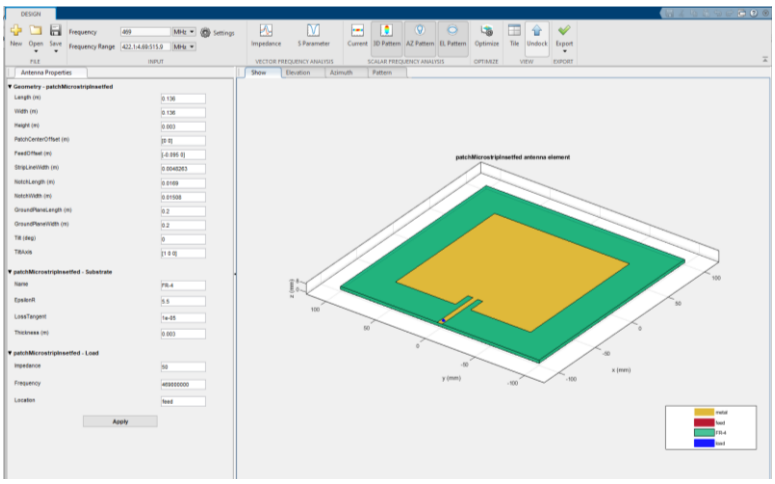


Figure 7 – Antenna Designer application interface

Calculated in *the Antenna app Designer* of the MSPA RP is presented in Figure 8.

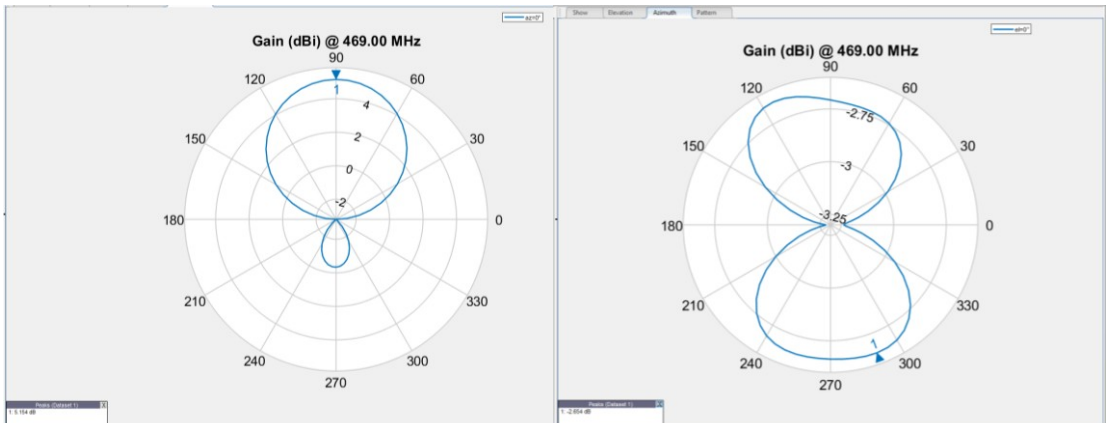
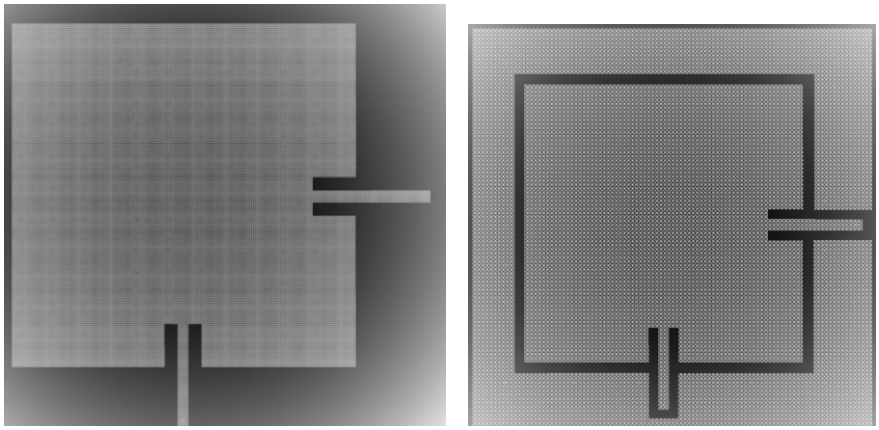


Figure 8 – MSPA RP graphs from the Antenna Designer application

It is clearly visible that the RP calculated using formulas (3) and in *The Antenna Designer application* are practically identical (Fig. 6 and 8).

FR4 fiberglass substrate was designed. A daisy-chain feeder from a coaxial-to-strip adapter, which also serves as the antenna connection point to the feeder via an SMA connector, was selected. Using the Sprint program the layout created a topology of the antenna resonator with a power supply loop in two versions - unshielded and shielded (Fig. 9).



a) b)

Figure 9 – The main resonator of the MSPA prototype, created in the Sprint Layout environment a) unshielded MSPA; b) shielded MSPA

The antenna prototype was manufactured by milling double-sided foil-clad fiberglass FR 4 from AB retail thickness 3 mm (Fig. 10).

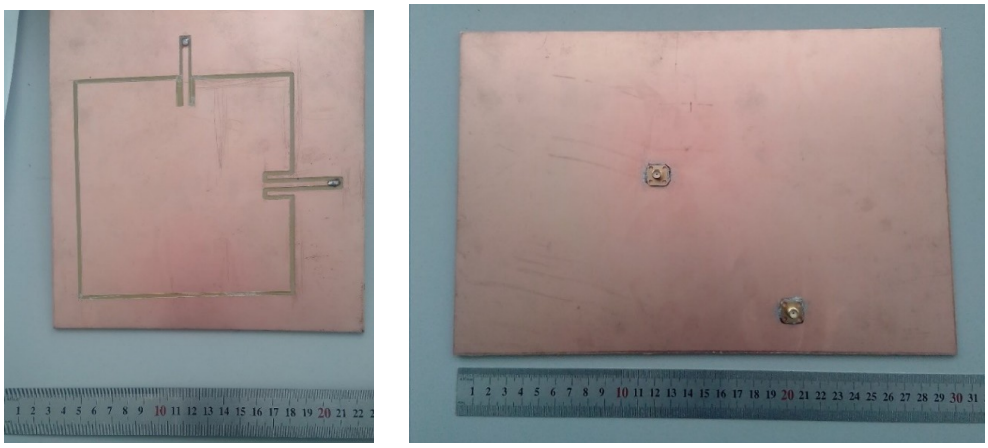


Figure 10 – A variant of the implementation of the MSPA prototype (working model) for measuring parameters

The actual permittivity of FR 4 fiberglass was lower than the manufacturer's stated value of 5.0–5.5 (the actual value was 4.4), necessitating precise tuning of the antenna to the selected frequency by adjusting its dimensions. To increase the antenna's resonant frequency, the antenna panel dimensions were reduced by trimming the resonator edge. To lower the frequency, narrow foil strips were soldered on. To significantly reduce the frequency, a section of the conductive shield on the active side of the antenna was used, connected to the antenna patch with shorting jumpers in several places (Fig. 11).

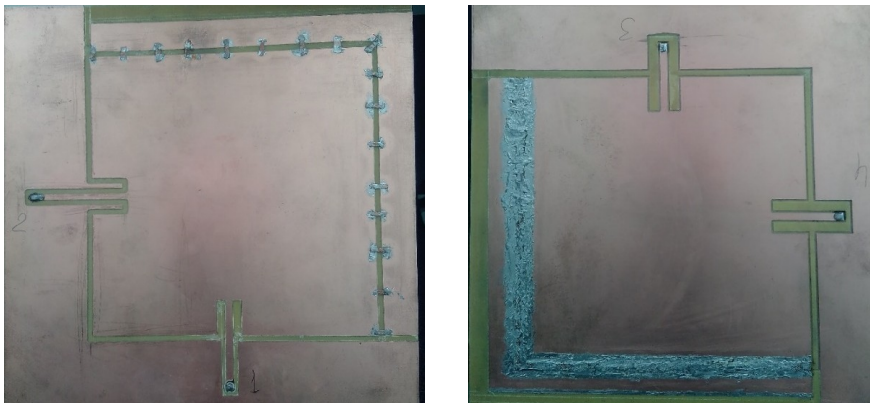


Figure 11 – Experimental models of MSPA with post - fine tuning to a frequency of 469 MHz

The resonant frequency was controlled using an Anritsu device. The S 362 E antenna and feeder line analyzer option measures the voltage standing wave ratio (VSWR) and input impedance in panoramic VSWR meter modes and using the Smith chart. For antenna and feeder line measurements, the Anritsu device The S 362E must be calibrated together with the connecting cable. Three types of loads are used for this procedure: open feeder, short-circuited load, and matched load.

An example of antenna tuning results for a bistatic radar system is shown in Figure 12. The MP antenna was tuned at input 2 for this antenna, and similar studies were conducted for the second antenna. The resulting VSWR is 1.23–2.05, and the bandwidth is approximately 10 MHz at a 3 dB level.

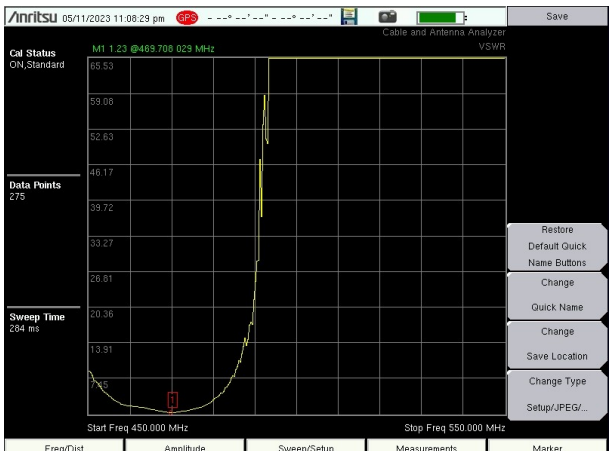


Figure 12 – Measuring the VSWR of the MSPA "1" at input 1

The measured gain factors of the experimental antenna models were:

– for model 1: vertical polarization 5.3 dB (1.84); horizontal polarization 4.9 dB (1.76);

– for layout 2: vertical polarization 4.8 dB (1.74); horizontal polarization 4.7 dB (1.72).

The results of measuring the antenna gains are in good agreement with those calculated in *The Antenna Designer*, which is 5.15 dB (1.81).

To calculate the power flux density of the transmitter signal and the sensitivity of the receiver, it is advisable to select the antenna gain value with a margin of 1.5 to compensate for random deviations in the radiation pattern.

Due to the lack of the correct conditions necessary for measuring the amplitude radiation pattern of the MSPA (there is no anechoic measuring chamber, it is impossible to move the stationary equipment to an open space for the arrangement of an antenna range), it was decided to use the method for measuring the radiation pattern proposed in the 90s of the last century at the Department of AFU of the Air Force Engineering Academy named after prof. N.E. Zhukovsky [14]. The essence of this method lies in the statistical processing of a large number of measurement results made under non-ideal conditions under the influence of random reflections from interfering objects.

A series of measurements with deliberately different reflection conditions (to ensure this, the auxiliary antenna—the transmitting one if the receive directivity characteristic is being measured, or the receiving one if the measurement is in transmit mode—is moved by distances multiples of a quarter-wavelength for each individual measurement) are then processed together: for each angular position of the antenna being studied, the average field amplitude is found. The resulting average values are normalized and presented graphically in the selected scale and the required coordinate system.

Two series of RP measurements were conducted for vertical and horizontal polarizations – 5 and 7 measurement sets, respectively. Each measurement set differed in the placement of the auxiliary antenna: in five (seven) sets, the auxiliary antenna was shifted transversely and longitudinally by a quarter-wavelength ($\lambda/4 = 16$ cm) from the initial position; in the other three sets (separately for each polarization), the auxiliary antenna was shifted vertically by half a wavelength ($\lambda/2 = 32$ cm). The results from all sets for each angle were averaged and then normalized. A total of 450 field strength measurements were performed in 18 measurement sets.

The averaged normalized characteristics of the RP, shown in Figures 13 and 14 (red color), coincide quite accurately with the calculated ones (blue color).

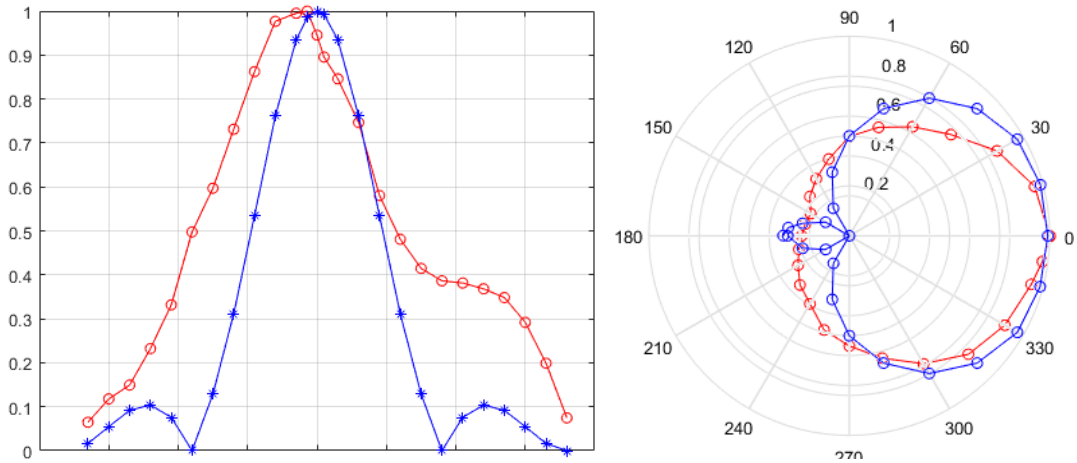


Figure 13 – RP of a vertically polarized antenna Fv(θ) in Cartesian and polar coordinates

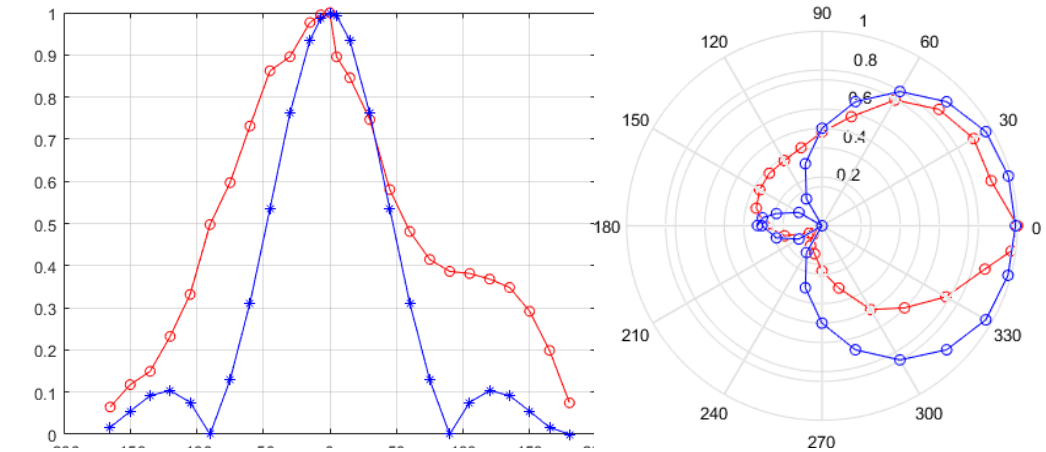


Figure 14 – RP of a horizontal polarization antenna Fv(θ) in Cartesian and polar coordinates

Rationale for the choice of transmission line type. Microstrip transmission lines are well matched to printed antennas in terms of their characteristic impedance and design. However, their use can only be achieved by using printed technology for all elements of the transmit-receive paths in the centimeter and millimeter wave bands. Furthermore, the transmission line lengths in the transmitting and receiving sections of the dual-position radar being developed are insignificant, and the anticipated hardware complexity of the devices being developed is low. Therefore, it is advisable to use coaxial flexible cables with a characteristic impedance of 50 ohms for the prototype. Joints between different transmission line types should preferably be implemented using a coaxial-to-strip transition.

It should be noted that the radar system's intended use requires the transmitter, transmitting antenna, and receiving and measuring device to be mounted onboard the UAV. This places special demands on the operational parameters of the radar system being developed. Specifically, the coaxial connectors must be tightly secured and secured with appropriate devices (safety wire, locking washers, etc.).

Research results and discussion. Experimental studies of antenna-feeder devices for UAV-based radars indicate that the use of MSPA is the most feasible option. This is due to the ability to generate unidirectional radiation, ensure stable electrical parameters across the operating frequency range, and ease of manufacture.

Conclusion. This article examines the operational features of a UAV-mounted radar and formulates requirements for the radar's antenna feeder. Based on the developed requirements, an

analysis was conducted of the feasibility of using existing radar antennas for the radar system, which concluded that such a choice was impractical. A selection of micro-band antennas for the UAV-mounted radar was also conducted. The characteristics of the manufactured antenna feeder for the radar were calculated, modeled, and analyzed.

The direction of further research related to improving the operation of antennas for radars is the study of the possibility of using two-element antenna arrays for radar antenna feeds.

Список источников

1. Bazhenov A., Sagdeev K., Goncharov D., Grivennaya N. Bistatic system for radar sensing of soil moisture // Engineering for Rural Development: 20. 2021. Vol. 20. P. 919–925. https://doi.org/10.22616/ERDev.2021.20.TF207
2. Линец Г. И., Баженов А. В., Гривенная Н. В., Гончаров В. Д. Радиолокационное измерение комплексной относительной диэлектрической проницаемости и объемной влажности почвы. Радиоэлектронные устройства и системы для инфокоммуникационных технологий ("РЭУС-ИТ 2023"): Доклады Всероссийской конференции, посвящённой "Дню радио", Москва, 07–09 июня 2023 года. Москва: РНТОРЭиС им. А.С. Попова, 2023. С. 79-83.
3. Воскресенский Д. И., Степаненко В. И., Филиппов В. С. Устройства СВЧ и антенны. Проектирование фазированных антенных решеток: учебное пособие для ВУЗов; под общ. ред. Д. И. Воскресенского. М.: Изд-во Радиотехника. 2003. 632 с.
4. Сазонов Д.М. Антенны и устройства СВЧ. Учеб. для радиотехнич. спец. вузов; М.: Изд-во Высшая школа. 1988. 432 с.
5. Balanis C. A. Antenna Theory: Analysis and Design: Book. New Jersey: Wiley-Interscience, 2005. 1136 p.
6. Петров А. С., Макеев В. В. Анализ характеристик микрополосковых антенн в дециметровом диапазоне // Радиотехника и электроника. 2013. Т. 58. №. 3. С. 213–213.
7. Volakis J.L. Antenna Engineering Handbook. New York: McGraw-Hill, 2007. 1755 p.
8. Панченко Б. А., Нефедов Е. И. Микрополосковые антенны; М.: Изд-во Радио и связь. 1986. 144 с.
9. Харин Ю. С. Анализ применения полосковых и микрополосковых антенн в системах связи специального назначения // Актуальные вопросы эксплуатации систем охраны и защищенных телекоммуникационных систем. 2018. С. 196–197.
10. Гусинский А. В., Свирид М. С., Кондрашов Д. А., Копшай А. А., Булавко Д. Г., Лисов Д. А. Моделирование микрополосковой антенны радиовысотомера для летательного аппарата //Доклады Белорусского государственного университета информатики и радиоэлектроники. 2021. Т. 19. №. 5. С. 5–12.
11. Савочкин А. А., Чуян В. А. Разработка и исследование микрополосковой антенны MIMO // Modern Science. 2020. Т. 7. №. 2. С. 392–396.
12. James J. R., Hall P. S. Handbook on Microstrip Antennas. London: Peter Peregrinus Ltd, 1989. 1311 p.
13. Kao-Cheng H., Edwards D. J. Millimetre Wave Antennas for Gigabit Wireless Communications: A Practical Guide to Design and Analysis in a System Context. JohnWiley & Sons Ltd, 2008. 271 p.
14. Меркулов В. И., Гандурин В. А., Дрогалин В. В. Авиационные системы радиоуправления: учебник для военных и гражданских ВУЗов. М.: ВВИА им. Н.Е. Жуковского. 2008.

References

1. Bazhenov A., Sagdeev K., Goncharov D., Grivennaya N. Bistatic system for radar sensing of soil moisture. Engineering for Rural Development: 20. 2021. Vol. 20. P. 919–925. https://doi.org/10.22616/ERDev.2021.20.TF207
2. Linets G. I., Bazhenov A. V., Grivennaya N. V., Goncharov V. D. Radiolokatsionnoe izmerenie kompleksnoi otnositel'noi diehlektricheskoi pronitsaemosti i ob"emnoi vlazhnosti pochvy. Radioehlektronnye ustroistva i sistemy dlya infokommunikatsionnykh tekhnologii ("REHUS-IT

2023"): Doklady Vserossiiskoi konferentsii, posvyashchennoi "Dnyu radio", Moskva, 07–09 iyunya 2023 goda. Moskva: RNTOREhIS im. A.S. Popova, 2023. S. 79-83.
3. Voskresenskii D. I., Stepanenko V. I., Filippov V. S. Ustroistva SVCH i antenny. Proektirovanie fazirovannykh antennykh reshetok: uchebnoe posobie dlya VUZov; pod obshch. red. D. I. Voskresenskogo. M.: Izd-vo Radiotekhnika. 2003. 632 s.
4. Sazonov D.M. Antenny i ustroistva SVCH. Ucheb. dlya radiotekhnich. spets. vuzov; M.: Izd-vo Vysshaya shkola. 1988. 432 s.
5. Balanis C. A. Antenna Theory: Analysis and Design: Book. New Jersey: Wiley-Interscience, 2005. 1136 p.
6. Petrov A. S., Makeev V. V. Analiz kharakteristik mikropoloskovykh antenn v detsimetrovom diapazone // Radiotekhnika i ehlektronika. 2013. T. 58. №. 3. S. 213–213.
7. Volakis J.L. Antenna Engineering Handbook. New York: McGraw-Hill, 2007. 1755 r.
8. Panchenko B. A., Nefedov E. I. Mikropoloskovye antenny; M.: Izd-vo Radio i svyaz'. 1986. 144 s.
9. Kharin YU. S. Analiz primeneniya poloskovykh i mikropoloskovykh antenn v sistemakh svyazi spetsial'nogo naznacheniya. Aktual'nye voprosy ehkspluatatsii sistem okhrany i zashchishchennykh telekommunikatsionnykh sistem. 2018. S. 196–197.
10. Gusinskii A. V., Svirid M. S., Kondrashov D. A., Kopshai A. A., Bulavko D. G., Lisov D. A. Modelirovanie mikropoloskovoi antenny radiovysotomera dlya letatel'nogo apparata. Doklady Belorusskogo gosudarstvennogo universiteta informatiki i radioehlektroniki. 2021. T. 19. №. 5. S. 5–12.
11. Savochkin A. A., Chuyan V. A. Razrabotka i issledovanie mikropoloskovoi antenny MIMO. Modern Science. 2020. T. 7. №. 2. S. 392–396.
12. James J. R., Hall P. S. Handbook on Microstrip Antennas. London: Peter Peregrinus Ltd, 1989. 1311 p.
13. Kao-Cheng H., Edwards D. J. Millimetre Wave Antennas for Gigabit Wireless Communications: A Practical Guide to Design and Analysis in a System Context. JohnWiley & Sons Ltd, 2008. 271 p.
14. Merkulov V. I., Gandurin V. A., Drogalin V. V. Aviatsionnye sistemy radioupravleniya: uchebnik dlya voennykh i grazhdanskikh VUZov. M.: VVIA im. N.E. Zhukovskogo. 2008.

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ТЕХНИЧЕСКИЕ НАУКИ
ИНФОРМАТИКА, ВЫЧИСЛИТЕЛЬНАЯ ТЕХНИКА И УПРАВЛЕНИЕ

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Комплексная модель обнаружения аномалий в распределённых системах с применением спектральных и биометрических методов

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Аннотация. ***Введение.*** В статье рассмотрена интеграция спектрального анализа сетевого поведения и современных биометрических методов аутентификации. ***Цель.*** Целью исследования является повышение безопасности распределённых вычислительных систем. Перспективы дальнейших исследований включают использование вейвлет-преобразований для анализа нестационарных трафиков, адаптацию порогов обнаружения в зависимости от контекста пользователя. ***Материалы и методы.*** Модель включает использование рядов Фурье для анализа периодичности сетевых процессов, а также применение FaceNet, VGGFace и IrisCode для корректной идентификации пользователей. Представлена корреляционная модель, объединяющая биометрические и спектральные характеристики пользователя, позволяющая формировать интегральный показатель риска. ***Результаты и обсуждение.*** Проведён численный анализ, демонстрирующий возможность разделения нормальных пользователей и злоумышленников по спектральным характеристикам поведения. Графические результаты подтверждают эффективность предлагаемой модели. ***Заключение.*** По итогам проведенного исследования можно сделать вывод о том, что применение разложения в ряды Фурье позволяет формализовать поведенческий профиль пользователя в частотной области и выявлять высокочастотные компоненты, характерные для автоматизированных атак.

Ключевые слова: распределённые системы; безопасность; обнаружение аномалий; спектральный анализ; ряды Фурье; биометрическая аутентификация; FaceNet; VGGFace; IrisCode; поведенческий анализ; сетевой трафик; корреляционная модель риска; Fourier-спектр; IDS.
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Research article

Comprehensive anomaly detection model for distributed systems using spectral and biometric methods

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Abstract. ***Introduction.*** The article discusses the integration of spectral analysis of network behavior and modern biometric authentication methods. ***Goal.*** The goal of the research is to improve the security of distributed computing systems. Further research prospects include the use of wavelet transformations for analyzing non-stationary traffic, and the adaptation of detection thresholds based on the user's context. ***Materials and methods.*** The model includes the use of Fourier series to analyze the periodicity of network processes, as well as the use of FaceNet, VGGFace, and IrisCode for the correct identification of users. A correlation model is presented that combines the biometric and spectral characteristics of a user, allowing for the formation of an integrated risk indicator. ***Results and discussion.*** A numerical analysis has been conducted to demonstrate the possibility of separating normal users and attackers based on the spectral characteristics of their behavior. The graphical results confirm the effectiveness of the proposed model. ***Conclusion.*** Based on the results of this study, it can be concluded that the use of Fourier series decomposition allows for the formalization of a user's behavioral profile in the frequency domain and the identification of high-frequency components characteristic of automated attacks.
Key words: Distributed systems, Fourier analysis, biometric authentication, FaceNet, IrisCode, VGGFace, spectral anomaly detection, network traffic modeling, intrusion detection systems, user behavior profiling, ROC optimization, information security.
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Введение. Современные распределённые вычислительные системы характеризуются высокой динамичностью топологии, большим числом взаимодействующих узлов и неоднородностью сетевых протоколов, что усложняет обеспечение их информационной безопасности. Рост интенсивности автоматизированных атак, использование ботнетов, распределённых сканеров и подмены легитимных учётных данных повышают значимость методов, позволяющих выявлять отклонения поведения пользователей после аутентификации. Традиционные системы обнаружения вторжений преимущественно опираются на сигнатурные или статистические модели и недостаточно эффективны при анализе слабовыраженных и высокочастотных аномалий, маскируемых под легитимный трафик.

Одновременно биометрические методы аутентификации демонстрируют высокую устойчивость к компрометации учётных данных, однако они не обеспечивают контроль действий пользователя после успешного входа. Это создаёт необходимость применения комплексного подхода, объединяющего подтверждение личности и анализ её последующего сетевого поведения. В данной работе предлагается интегральная модель обеспечения безопасности распределённых систем, основанная на разложении сетевого трафика в ряды Фурье для выделения спектральных признаков поведения [1], а также на

применении современных алгоритмов биометрической идентификации (FaceNet [2], VGGFace [3], IrisCode [4]). Введён интегральный критерий риска, учитывающий биометрическую близость к шаблону пользователя и спектральное отклонение от эталонного поведения. Показано, что предложенный подход позволяет увеличить достоверность обнаружения аномалий и снизить вероятность ложных допусков.

Математическое моделирование сетевых процессов. Трафик распределённой системы можно формализовать как функцию *f(t),* описывающую интенсивность обмена пакетами, задержку или уровень загрузки сети. Поскольку сетевые процессы нередко обладают периодической компонентой (например, периодические heartbeat-сообщения, циклы синхронизации), такой временной ряд может быть представлен разложением в ряд Фурье:

$$f(t) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{2\pi nt}{T} + b_n \sin\frac{2\pi nt}{T} \right), \quad (1)$$

где: T – характерный период наблюдаемой системы.

Коэффициент a_n:

$$a_n = \frac{2}{T}\int_0^T f(t)\cos\frac{2\pi nt}{T}dt\,.$$

Коэффициент b_n:

$$b_n = \frac{2}{T}\int_0^T f(t)\sin\frac{2\pi nt}{T}dt\,.$$

Высокие значения коэффициентов a_n и b_n на определённых частотах отражают устойчивую повторяющуюся активность. В нормальном режиме спектр распределённой системы характеризуется стабильными частотами, соответствующими:

- регулярным синхронизациям узлов;
- циклическому обновлению маршрутов;
- фоновым сетевым процедурам.

Пусть наблюдается изменение спектра на частоте ω_k. Тогда, для выявления атак с помощью спектральных методов можно ввести метрику отклонения:

$$D(\omega_k) = \left| S_{текущее}(\omega_k) - S_{опорное}(\omega_k) \right|, \quad (2)$$

где *S(ω)* — амплитудный спектр:

$$S(\omega_n) = \sqrt{a_n^2 + b_n^2},\ \omega_n = \frac{2\pi n}{T}\,.$$

Если *D(ωk)* превышает порог δ_k, фиксируется аномалия:

$$D(\omega_n) > \delta_n\,.$$

Возникновение новых частотных компонент или усиление гармоник может свидетельствовать об аномальной активности, такой как:

- скрытое сканирование сети, что проявляется в виде низкочастотных периодических всплесков;
- DDoS-атаки, демонстрирующие рост высокочастотной составляющей;
- внедрение вредоносного ПО, вызывающее появление новых регулярных шаблонов обмена.

Пользователь может пройти биометрию, но затем его поведение может отличаться спектрально и тем самым демонстрировать аномальные сетевые частоты, характерные для автоматизированных скриптов, ботов и скрытого сканирования сети. Дополнительный спектральный анализ показывает разницу спектров $\Delta S(\omega)$ по (2) [1], [2].

Фурье-анализ позволяет выявлять такие несоответствия. Для сравнения поведения воспользуемся выражением:

$$\Delta S(\omega) = \left| S_{mal}(\omega) - S_{norm}(\omega) \right|.$$

ΔS выделяет частоты, на которых злоумышленник отличается от нормального пользователя. Графики спектров сетевого временного ряда нормального пользователя, злоумышленника и $\Delta S(\omega)$, полученные с помощью преобразования Фурье, представлены на рисунках 1 – 3 [1].

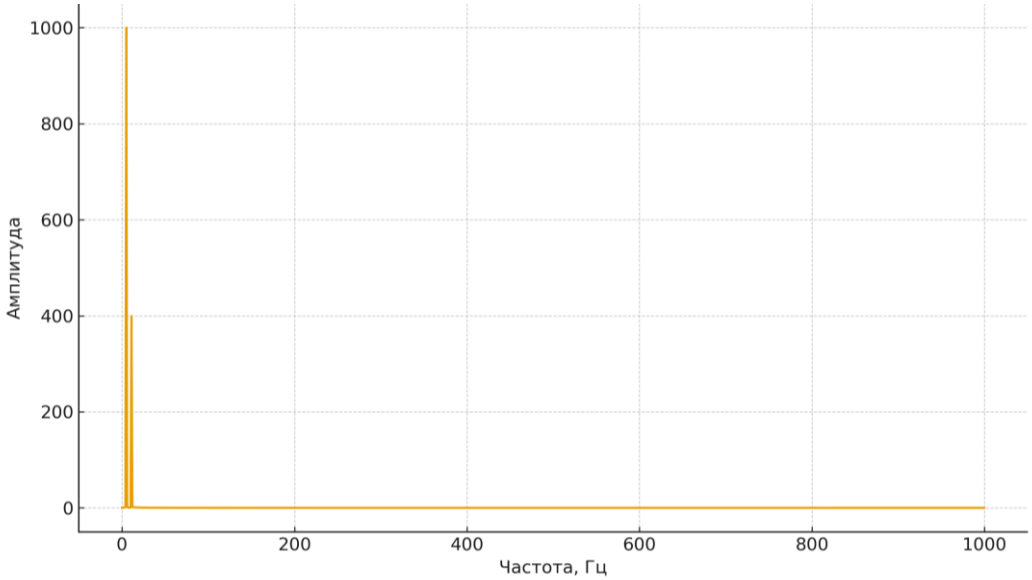

Рисунок 1 – Спектр нормального пользователя / Figure 1 – The spectrum of a normal user

На графике видны два доминирующих пика на низких частотах (около 5÷11 Гц). Это соответствует регулярной, «человеческой» активности: обычные запросы, навигация, стандартные операции в системе. Спектр относительно «чистый», без плотного высокочастотного «грязного» шума.

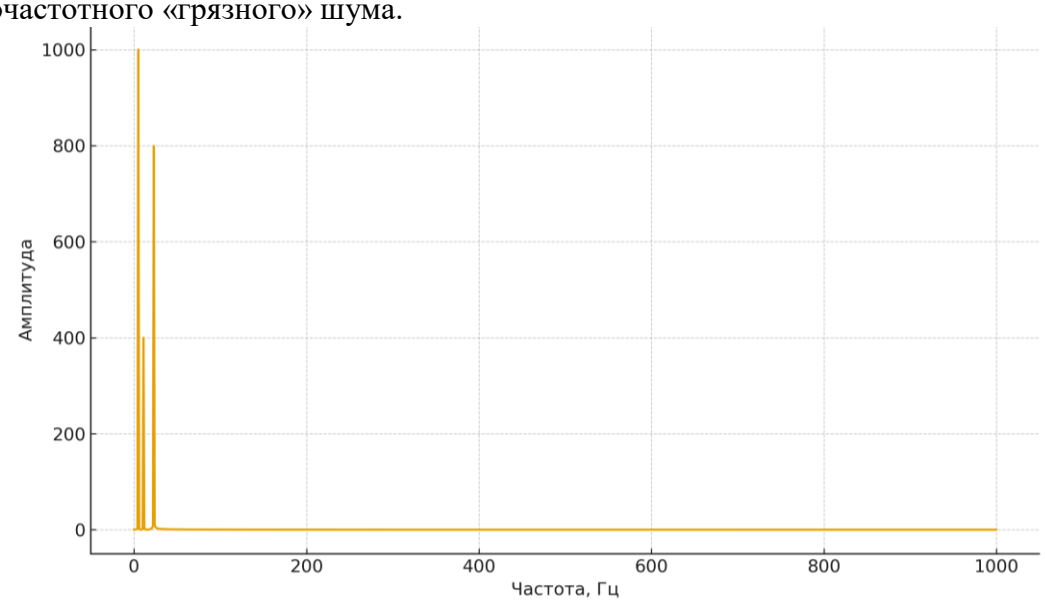

Рисунок 2 – Спектр злоумышленника / Figure 2 – The attacker's spectrum

Здесь, помимо нормальных компонент, появляется выраженный пик на более высокой частоте (около 23 Гц) и в целом усиливается частотная область. Такое поведение характерно для:

- частых однотипных запросов (скрипты, боты),
- сканирования портов/сервисов,
- автоматизированных атак с фиксированным временным шагом.

Для более глубокого анализа поведения пользователей введена метрика разницы спектров между нормальным и аномальным поведением. Метрика $\Delta S(\omega)$ позволяет выявить частоты, на которых наблюдаются существенно выраженные отклонения.

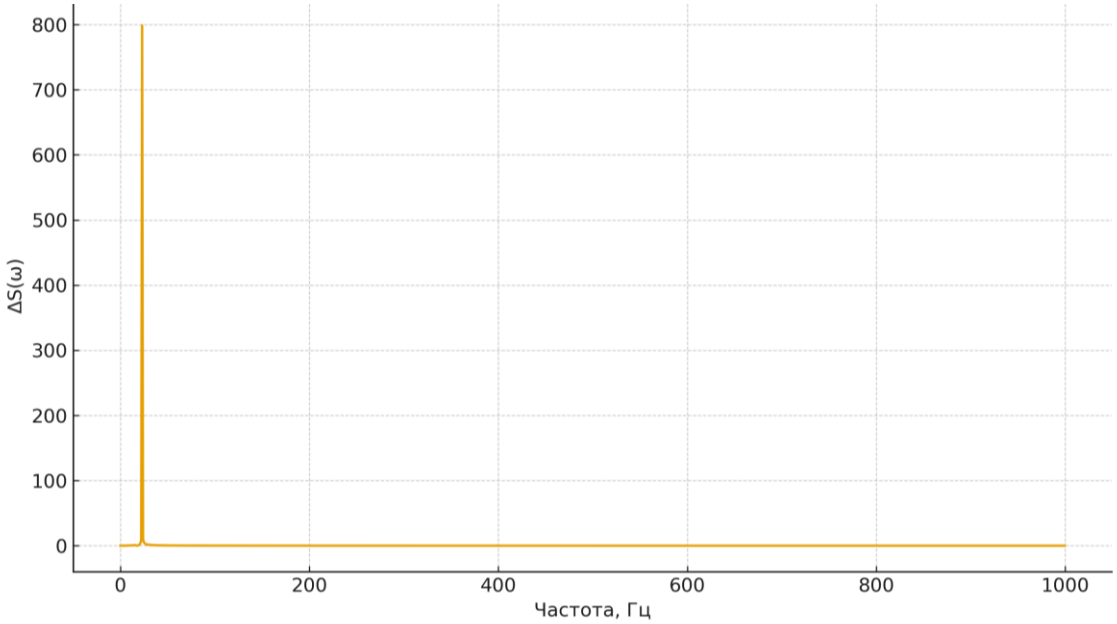

Рисунок 3 – Разность спектров $\Delta S(\omega)$ / Figure 3 – Difference of spectra $\Delta S(\omega)$

График $\Delta S(\omega)$ подчёркивает именно зоны отличий между нормальным и атакующим профилем. На низких частотах $\Delta S(\omega)$ обычно мала — злоумышленник имитирует нормальные действия. На частотах, соответствующих автоматизированной активности, наблюдаются ярко выраженные пики $\Delta S(\omega)$. Это создаёт удобный критерий для настройки порогов детектирования, вычисления интегрального показателя риска $K(u)$ и обучения моделей классификации «норма/атака».

Рост доли HTTPS и VPN приводит к невозможности применения методов анализа содержимого пакетов. В таких условиях актуальны подходы, основанные на спектральных и гибридных Fourier–Wavelet моделях, позволяющих классифицировать зашифрованный трафик по временным закономерностям без расшифрования. Такие подходы успешно применяются для выявления туннельных каналов, скрытых команд и аномальных периодических сигналов с автоматизацией [7].

Несмотря на классическое применение разложения в ряды Фурье [1], сетевой трафик обладает непостоянной частотной структурой, что требует применения вейвлет-преобразований. Вейвлет-анализ позволяет выделять локальные частотные особенности активности пользователя, что делает его эффективным дополнением к Fourier-моделям. Метод позволяет выявлять краткоживущие всплески активности, характерные для атак краткого периода (например, инъекций или сканирования) [8].

Современные распределённые системы требуют многослойной защиты, которая предотвращает как внешние сетевые атаки, так и внутренние злоупотребления. В данной работе предложена интеграция спектрального моделирования сетевых процессов (с использованием рядов Фурье) и биометрической идентификации пользователей, обеспечивающая согласованное повышение уровня защищённости. Эта связь формируется на трёх методологических уровнях: математическом, поведенческом и архитектурном [5].

Биометрические сигналы (в частности, IrisCode и FaceNet embeddings) также могут быть интерпретированы как периодические или квазипериодические. Последовательность данных IrisCode, описывающая фазовые характеристики радужки в полярной системе

координат, использует фильтры Габора — разновидность частотных фильтров, основанных на локализованных гармониках. При обработке лица (FaceNet, VGGFace) применяется декомпозиция изображений в пространственно-частотных признаках [5 – 7]. То есть биометрия уже «по природе» является частотным анализом, и ряды Фурье лежат в её основе.

Даже после успешной биометрической аутентификации поведение пользователя в системе должно контролироваться. И здесь спектральный анализ играет ключевую роль. Спектральный анализ подтверждает поведение пользователя (2), а биометрия подтверждает личность для пользователя u:

$$X_u = f(I_u)$$
$$d(X_u, R_u) \le \tau$$

где:

R_u – шаблон пользователя;

d — евклидово расстояние (FaceNet/VGGFace).

Интеграция спектральных методов и биометрической идентификации позволяет сопоставлять личность пользователя его цифровому поведенческому профилю. Биометрия подтверждает личность, тогда как спектральный анализ выявляет характерные частотные компоненты поведения, определяя отклонения, свойственные автоматизированным атакам [1]. Для объединения результатов биометрической аутентификации и спектрального анализа сетевого поведения вводится интегральный корреляционный критерий $K(u)$, определяемый для пользователя u. Пусть X_u — биометрический вектор признаков пользователя, R_u — его эталонный шаблон, $d(X_u, R_u)$ — метрика расстояния (евклидова), а $\Delta S(u)$ — нормированная метрика разницы спектров между текущим и опорным сетевым профилем данного пользователя. Тогда обобщённый критерий риска определяется выражением:

$$K(u) = \alpha \cdot d(X_u, R_u) + \beta \cdot \Delta S(u), \qquad (3)$$

где:

α — вес, позволяющий настроить модель по биометрии;

β — вес, позволяющий настроить модель по анализу поведения;

$K(u)$ — безразмерный показатель риска.

Весовые коэффициенты α и β выбираются в зависимости от приоритета точности биометрической аутентификации и чувствительности к аномалиям поведения. Чем выше значение $K(u)$, тем выше уровень подозрительности активности пользователя. При превышении порога $K_{пор}$ система инициирует дополнительные проверочные процедуры или блокировку сессии. Нормировка метрик $d(X_u, R_u)$ и $\Delta S(u)$ на интервал [0; 1] позволяет интерпретировать $K(u)$ как безразмерный риск-показатель, пригодный для сравнения между различными пользователями и сценариями атак.

Схема архитектурной интеграции спектрального моделирования сетевых процессов с биометрическим модулем представлена на рис. 4.

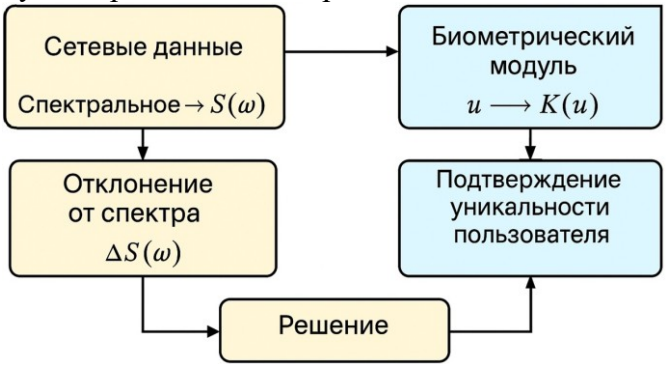

Рисунок 4 – Схема архитектурной интеграции спектрального моделирования сетевых процессов с биометрическим модулем / Figure 4 – Architectural Integration of Spectral Network Process Modeling with a Biometric Module

Помимо базовых сверточных архитектур FaceNet [2], современные системы применяют улучшенные векторные пространства, такие как FaceNet++ [9], использующие более плотные эмбеддинги и усиленную регуляризацию. Использование глубоких эмбеддингов повышает качество биометрической идентификации при низком качестве изображения, угловых искажениях и слабой освещенности. Подобные алгоритмы обеспечивают более точные оценки расстояния $d(X_u, R_u)$, что снижает вероятность ложных совпадений и усиливает роль биометрических факторов в расчёте интегрального критерия риска $K(u)$ [9].

Стандартизация биометрических данных является ключевым условием масштабируемости и интероперабельности систем аутентификации в распределённых вычислительных архитектурах. Стандарт ISO/IEC 19794-5:2011 определяет требования к структуре геометрических представлений лица, включая разметку ключевых точек, формат хранения и параметры совместимости между устройствами и сервисами биометрической обработки. Использование стандартизированных форматов позволяет корректно передавать биометрические шаблоны между облачными сервисами, edge-узлами и локальными компонентами системы, минимизируя потери точности и повышая устойчивость аутентификации к атакам повторного предъявления [10].

Результаты исследований и их обсуждение. Рассмотрим вычисление обобщённого критерия риска $K(u)$ для весов $\alpha = 0.6$ и $\beta = 0.4$ при нормированных метриках $d(X_u, R_u)$ и $\Delta S(u)$ в интервале [0; 1]. Били рассмотрены три пользователя со следующими показателями:

1) нормальный пользователь: $d = 0.15$, $\Delta S = 0.10$;
2) пограничный случай: $d = 0.30$, $\Delta S = 0.35$;
3) злоумышленник: $d = 0.55$, $\Delta S = 0.70$.

По формуле (3) были получены значения K(u):

K(нормальный) = 0.6·0.15 + 0.4·0.10 = 0.13;

K(пограничный) = 0.6·0.30 + 0.4·0.35 ≈ 0.32;

K(злоумышленник) = 0.6·0.55 + 0.4·0.70 = 0.61.

Таким образом, при выборе порогового значения $K_{пор}$ в диапазоне 0.4–0.5 нормальный пользователь и пограничный случай будут допущены, тогда как активность злоумышленника будет классифицирована как подозрительная и потребует дополнительных проверок.

На рисунке 5 представлены контурные линии значений $K(u)$ в зависимости от расстояния $d(X_u, R_u)$ и разницы спектров $\Delta S(u)$. Линейная структура изолиний отражает аддитивный характер модели.

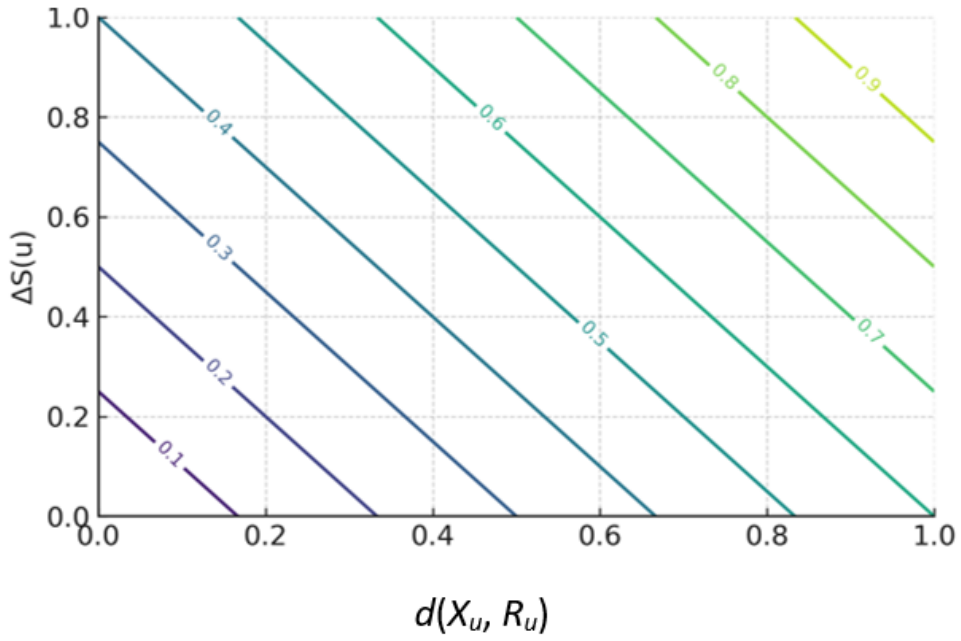

Рисунок 5 – Контуры уровня $K(u)$ при α = 0.6, β = 0.4 / Figure 5 – Contour Levels of $K(u)$ at α = 0.6, β = 0.4

Для фиксированного значения $\Delta S(u)$ функция $K(u)$ линейно возрастает с ростом $d(X_u, R_u)$, что позволяет интерпретировать вклад биометрической компоненты отдельно (рис. 6).

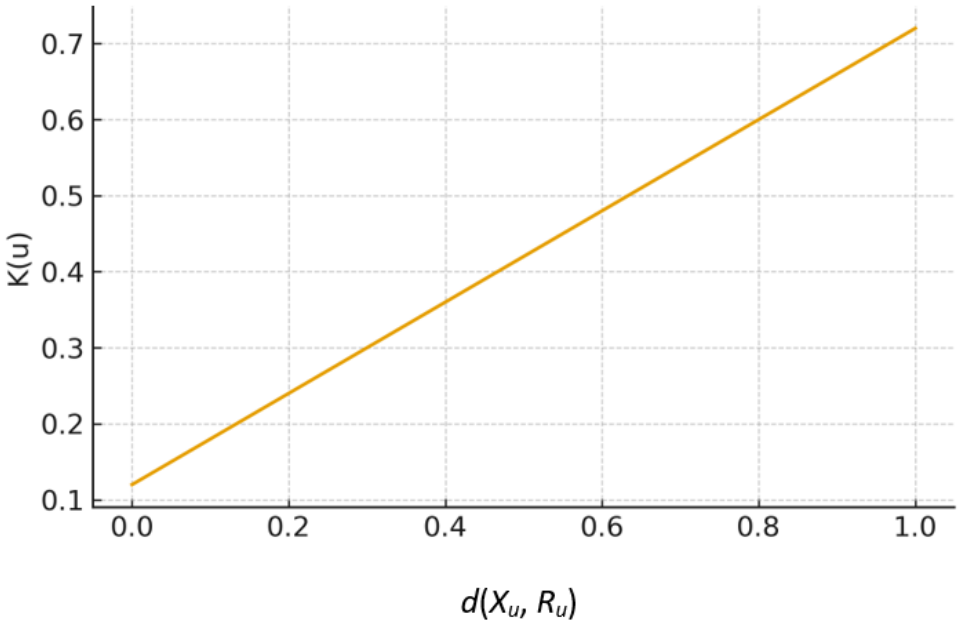

Рисунок 6 – Зависимость $K(u)$ от $d(X_u, R_u)$ при $\Delta S(u) = 0.3$ / Figure 6 – Dependence of $K(u)$ on $d(X_u, R_u)$ at $\Delta S(u) = 0.3$

Критерий $K(u)$ может быть использован для построения ROC-кривых, где по оси абсцисс откладывается уровень ложных допусков (FAR), а по оси ординат — уровень истинных срабатываний (TPR). Изменяя порог $K_{пор}$, можно получать различные пары значений (FAR, TPR) и тем самым выбирать оптимальный режим работы системы. Весовые коэффициенты α и β подбираются по экспериментальным данным с использованием методов оптимизации: минимизация EER, максимизация площади под

ROC-кривой (AUC) или многокритериальная настройка, учитывающая приоритеты оператора системы [11].

Таким образом, Фурье-анализ служит вторым уровнем защиты, контролируя поведение после биометрической проверки. Разложение в ряд Фурье позволяет выделить частотную структуру сетевой активности, выявить характерные гармоники и определить отклонения, связанные с аномальными воздействиями [4].

Этот подход позволяет:

- обнаруживать медленные атаки (slow-rate attacks);
- выявлять вредоносные периодические процессы;
- мониторить изменения в поведении протоколов консенсуса.

Заключение. В статье предложен комплексный подход к обеспечению безопасности распределённых вычислительных систем, основанный на совместном использовании биометрической идентификации и спектрального анализа сетевого трафика. Применение разложения в ряды Фурье позволяет формализовать поведенческий профиль пользователя в частотной области и выявлять высокочастотные компоненты, характерные для автоматизированных атак. Использование алгоритмов FaceNet, VGGFace и IrisCode обеспечивает надёжное подтверждение личности и снижает вероятность компрометации учётных данных.

Разработан интегральный критерий риска $K(u)$, объединяющий биометрическое расстояние и спектральное отклонение. Проведён численный анализ, демонстрирующий возможность разделения нормальных пользователей и злоумышленников по спектральным характеристикам поведения. Графические результаты подтверждают эффективность предлагаемой модели.

Перспективы дальнейших исследований включают использование вейвлет-преобразований для анализа нестационарных трафиков, адаптацию порогов обнаружения в зависимости от контекста пользователя и применение методов машинного обучения для классификации спектральных признаков [12].

Список источников

1. Оппенгейм А. Цифровая обработка сигналов. Prentice Hall, 2010.
2. Schroff F., Kalenichenko D., Philbin J. FaceNet: Unified Embedding for Face Recognition and Clustering // Proc. IEEE CVPR. 2015. pp. 815–823.
3. Parkhi O., Vedaldi A., Zisserman A. Deep Face Recognition // Proc. BMVC. Oxford Univ., 2015.
4. Daugman J. How IrisCode Works // IEEE Trans. Circuits and Systems Video Technology. 2003. Vol. 14. pp. 21–30.
5. Таненбаум Э., Ван Стин М. Распределённые системы: принципы и парадигмы. Pearson, 2020.
6. Столлингс В. Основы сетевой безопасности. Pearson, 2018.
7. Chen L., Sun M., Zhao Q. Hybrid Fourier-Wavelet Models for Encrypted Traffic Analysis // Computers & Security. 2023.
8. Mallat S. A Wavelet Tour of Signal Processing. — Academic Press, 2008.
9. Nguyen T., Vo M., Huynh D. FaceNet++: Enhanced Embedding Representations // Pattern Recognition Letters. 2024.
10. ISO/IEC 19794-5:2011. Информационные технологии. Биометрические форматы обмена данными. Часть 5: Геометрические данные лица.
11. Zhang Y., Liu H., Wang P. Fourier-Based Profiling of Network Behavior // IEEE Access. — 2021.
12. Kumar S., Patel R. Deep Biometric Fusion for Anomaly Detection // Journal of Network and Computer Applications. 2022.

References

1. Oppengeim A. Tsifrovaya obrabotka signalov. Prentice Hall, 2010.
2. Schroff F., Kalenichenko D., Philbin J. FaceNet: Unified Embedding for Face Recognition and Clustering. Proc. IEEE CVPR. 2015. pp. 815–823.

3. Parkhi O., Vedaldi A., Zisserman A. Deep Face Recognition. Proc. BMVC. Oxford Univ., 2015.
4. Daugman J. How IrisCode Works. IEEE Trans. Circuits and Systems Video Technology. 2003. Vol. 14. pp. 21–30.
5. Tanenbaum EH., Van Stin M. Raspredelennye sistemy: printsipy i paradigmy. Pearson, 2020.
6. Stollings V. Osnovy setevoi bezopasnosti. Pearson, 2018.
7. Chen L., Sun M., Zhao Q. Hybrid Fourier-Wavelet Models for Encrypted Traffic Analysis. Computers & Security. 2023.
8. Mallat S. A Wavelet Tour of Signal Processing. Academic Press, 2008.
9. Nguyen T., Vo M., Huynh D. FaceNet++: Enhanced Embedding Representations. Pattern Recognition Letters. 2024.
10. ISO/IEC 19794-5:2011. Informatsionnye tekhnologii. Biometricheskie formaty obmena dannymi. Chast' 5: Geometricheskie dannye litsa.
11. Zhang Y., Liu H., Wang P. Fourier-Based Profiling of Network Behavior. IEEE Access. 2021.
12. Kumar S., Patel R. Deep Biometric Fusion for Anomaly Detection. Journal of Network and Computer Applications. 2022.

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Contribution of the authors:

Igor V. Kaliberda - Conducting research – data collection, analysis and interpretation.
Approval of the final manuscript – acceptance of responsibility for all types of the work, integrity of all parts of the paper and its final version.

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Agentic AI как инструмент автоматизации продаж страховых продуктов: проектирование и реализация

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Аннотация. ***Введение.*** В статье, мы исследуем возможности Agentic AI как инструмента автоматизации продаж страховых продуктов, в работе также анализируется архитектура агентной системы включая модули обработки естественного языка (NLP), модуль взаимодействия с клиентом, принятия решений и интеграцию с CRM – системами. ***Методы исследования:*** в статье проведён анализ алгоритмов принятия решений, которые сочетают между собой методы машинного обучения и правила, позволяющие интеллектуальным агентам автономное инициирование взаимодействия с клиентами, предоставлять индивидуальные рекомендации клиентам и подстраиваться к поведению. ***Результаты и обсуждения.*** Автоматизация продаж страховых продуктов важна, в связи с ростом цифровизации, высокой конкурентностью и потребностью в персонализации. Научная новизна работы включает в себя комплексный подход, объединяющий в себе количественную оценку агентных систем в страховой сфере, а также внедрение и проектирование. В статье указывается способы влияния автономных интеллектуальных агентов на экономические показатели компании и улучшать клиентский опыт. В исследовании также учитывается влияние на долгосрочную точность прогнозирования, связанные с поведением клиентов, объёмом данных, срокам реализации пилотного проекта. ***Заключение*** Практическая значимость статьи основывается на разработке агентной системы и включает её внедрение в крупной страховой компании. Анализ показал эффективное ускорение обработки заявок, снижение затрат на привлечение и рост удержания клиентов, значительное повышение ROI и конверсии. Исследование рассматривает внедрение пилотного проекта только для одного вида страхового продукта, дальнейшие исследования по этой теме, можно расширить на другие продукты и сегменты рынка.

Ключевые слова: Agentic AI, автономность, цифровая трансформация, инновации, эффективность бизнеса.

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Research article

Agentic AI as a tool for automating insurance sales: design and implementation

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Abstract. ***Introduction.*** The article explores the potential of Agentic AI as a tool for automating the sales of insurance products. The study also analyzes the architecture of the agent system, including natural language processing (NLP) modules, client interaction modules, decision-making modules, and integration with CRM systems. ***Materials and methods.*** The article examines decision-making algorithms that combine machine learning methods with rule-based approaches, enabling intelligent agents to autonomously initiate client interactions, provide personalized recommendations, and adapt to client behavior.The automation of insurance product sales is particularly important due to the growing digitalization of the industry, high competition, and the increasing demand for personalization.The scientific novelty of the work lies in a comprehensive approach that combines quantitative evaluation of agent systems in the insurance sector with implementation and design. The article outlines how autonomous intelligent agents can influence a company's economic indicators and enhance the client experience. ***Results and discussion.*** The study also considers the impact on long-term forecasting accuracy, associated with client behavior, data volume, and the timelines of the pilot project implementation. The practical significance of the article is based on the development of an agent system and its implementation in a large insurance company. ***Conclusion.*** The analysis demonstrated effective acceleration of application processing, reduction of acquisition costs, increased client retention, and significant improvements in ROI and conversion rates. The study focuses on the implementation of a pilot project for a single type of insurance product; further research could extend this approach to other products and market segments.

Key words: vibration combustion, acoustic oscillations, wave modes, chemically reacting gas suspension
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Introduction. In recent years, given the widespread development of digital technologies, customer expectations in the insurance market have increased significantly. Insurance companies are now improving the speed and quality of service. To automate information processing and improve customer service, digital technologies are being integrated into workflows. This reduces costs and improves organizational quality, ultimately leading to increased efficiency and competitiveness.

In the insurance industry, the workload on employees is increasing, slowing down key operations. This is due to insufficient sales automation. Significant amounts of money and resources are spent on attracting new clients, putting pressure on the business and hindering growth opportunities.

Artificial intelligence is a technology for creating a system capable of learning and operating in changing conditions, in which decision making occurs similar to the human thought process [1].

Agentic AI is a type of artificial intelligence that does not require human control over it.

Agentic AI, an automated digital system, includes modules for natural language processing, targeted planning, and decision making, which facilitate customer interactions and automate sales processes.

According to research, artificial intelligence (AI) is transforming the insurance industry, including customer interaction methods [2]. Agentic AI has the ability to fully adapt to the client, provide recommendations, which increases efficiency and reduces operating costs.

Models for assessing customer risk have been actively used for several years, with considerable attention paid to preventing customer fraud [3].

The purpose of the study is to analyze effective models for using Agentic AI to increase sales and improve customer focus in the insurance industry.

Research objectives:

1. Explore and analyze methods for using Agentic AI to automate sales in the insurance industry;
2. Develop algorithms for an agent system for its implementation in corporate processes;
3. Develop recommendations for the use of agent systems in insurance companies.

With increasing digitalization, the core competencies in demand are changing as more functions require technological skills [4].

The fundamental principles of agent systems are their operational efficiency. Their ability lies in following key rules: autonomy, goal-setting, and adaptability.

Autonomy allows the system to make decisions and perform tasks independently, without human intervention.

Goal setting implies the system's ability to set goals and plan any actions.

Adaptability refers to the ability of a technology to analyze new data and learn.

These principles, when applied by insurance companies, optimize sales processes, speed up application processing, and improve the quality of customer interactions.

According to Bryzgalov D.V., Gryzenkova Yu.V., Tsyganov A.A., digitalization of communications with policyholders/insured persons is implemented through Internet systems technologies - the organization of personal accounts, chats on websites and in mobile applications (90%), as well as through electronic document management (57%) [5].

Innovations do not arise by themselves. They must be managed, both at the macro level and at the level of individual organizations [6].

What's the difference between classic AI systems and traditional chatbots from Agentic AI? The difference is that classic AI systems operate according to preset algorithms and require constant human intervention for adjustments and additions. Traditional chatbots are limited to pre-defined conversational scenarios.

Agentic AI, in turn, is capable of independently solving problems, optimizing operations, adapting to a specific environment, and interacting with clients.

The Agentic AI architecture consists of four key principles that enable the system's autonomous operation:

- *Natural Language Processing (NLP)* – enabling interaction with users through understanding text and generating specific responses;
- *Decision Engine* – analyzes data, makes decisions and selects the optimal strategy for further actions ;
- *Action planning (Planning)* – forms and organizes actions, taking into account priorities and constraints;
- *CRM integration* – ensures interaction and allows the use of information from corporate systems.

Research materials and methods. To assess the effectiveness of Agentic AI implementation in the insurance company's sales and customer interaction processes, we will use data on internal sales processes, employee workload, sales statistics, and application processing speed. Additionally, we will analyze data from the CRM system and customer interaction reports.

The methodological basis of the study is based on:

- principles of systems analysis - allows for the study of corporate processes, identifies the relationships between stages of work and provides an assessment of changes in overall efficiency;

- Comparative study of digital tools - to design a more effective agent system, one needs to understand the strengths and weaknesses.
- Agentic AI behavior modeling – analyze the performance of agent systems in a virtual environment and assess the impact on sales.

The methods specified were chosen to objectively evaluate the data, understand the effectiveness of new tools, and safely implement the prototype system.

The indicators before the implementation of Agentic AI reflect: low level of automation, high cost of customer acquisition, high workload for operators, low percentage of conversion to sales (Table 1).

Objective: To determine and analyze the level of efficiency of an insurance company before implementing Agentic AI.

Table 1 – Results of determining the level of work efficiency before the implementation of Agentic AI.

Indicator	Values before implementation
Average application processing time	40 minutes
Conversion to sales	8%
Cost of attracting one client	3000 rubles
Customer Retention Rate	55%
Load on operators	80

Source: compiled by the author based on an analysis of data collected prior to the implementation of Agentic AI.

To achieve these objectives, and given the insurance company's initial operational efficiency, it was decided to launch a pilot project using an autonomous agent system comprising four key modules.

To implement the Agentic AI pilot project and evaluate its effectiveness, a model of five sequential processes is used (Fig. 1).

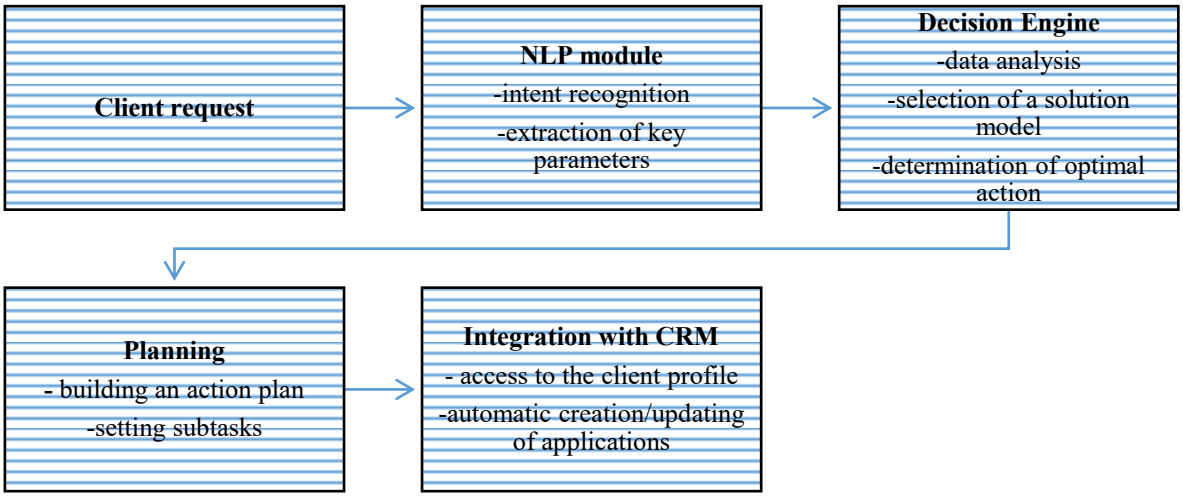

Figure 1 – Descriptive graphical model of the Agentic AI autonomous system.
Source: compiled by the author based on the implemented pilot project of Agentic AI.

The presented autonomous model is capable of analyzing client behavior, solving incoming problems, choosing a strategy, and conducting a full application processing cycle.

Research results and discussion. After the pilot system was launched, the results changed significantly. Due to automation, the workload on operators was reduced, customer retention increased, and the conversion rate to sales increased (Table 2).

Objective: To explore the capabilities of the presented autonomous model of the Agentic AI pilot project.

Table 2 - Results of determining the level of work efficiency after the implementation of Agentic AI.

Indicator	Values after implementation
Average application processing time	20 minutes
Conversion to sales	25%
Cost of attracting one client	1500 rubles
Customer Retention Rate	70
Load on operators	55

Source: compiled by the author based on an analysis of data collected after the implementation of Agentic AI.

Comparing the results of the first and second tables, we obtain the percentage of implementation effectiveness (Table 3).

Table 3 – Comparative analysis of the dynamics of key indicators (before/after implementation).

Indicator	Values before implementation	Values after implementation	Implementation efficiency (%)
Average application processing time	40 minutes	20 minutes	50% reduction
Conversion to sales	8%	25%	212.5% growth
Cost of attracting one client	3000 rubles	1500 rubles	50% reduction
Customer Retention Rate	55%	70	27.3% growth
Load on operators	80	55	31.25% decrease

Source: Compiled by the author based on the comparison before and after the implementation of the Agentic AI pilot project.

In this study, we found that the overall effectiveness of Agentic AI implementation increased the speed of claim processing in an insurance company by 74.2%.

Our data confirm the findings of Belova A.O. in the study “Economic efficiency of CRM system implementation: analysis of advantages and indicators” [8].

CRM strategy involves the use of specialized, advanced tools and technologies for interacting with customers, enabling companies to build mutually beneficial relationships by prioritizing their needs. This results in increased competitiveness and increased profits [7].

In her research, she examines the importance and economic benefits of customer relationship management systems. Belova A.O. notes that, with a competent approach, the implementation of CRM systems has a positive impact on business performance [8].

B. Ivens, K. Kasper-Brauer, A. Leischnig, and S.K. Thornton examine various methods of CRM system implementation in their study, but our data demonstrates one successful configuration. It leads to a significant increase in KPIs. These discrepancies in the studies are due to the different industries, business scales, and organizational levels [9].

The efficiency of the implemented agent-based AI's request processing is explained by its clear algorithm. This allows for automatic classification and prioritization of customer requests.

The obtained results can be used by the insurance company to optimize its processes.

This study is limited in that the analysis only demonstrates the use of agent-based AI in one insurance product category. Future studies could explore the use of agent-based AI across a broader range of services.

Conclusion. The key impact of agent-based artificial intelligence on company performance is: 1. improving customer experience; 2. increasing productivity; 3. increasing key performance indicators (retention, conversion, ROI).

The potential for comprehensive use of agent systems in the insurance industry and their value in business processes is confirmed by our research.

The use of agent system automation increases the level of interaction with clients, which can affect the company's reputation, and also has an impact on the company's financial performance, including cost reduction and increased ROI.

The study demonstrated that the implementation of Agentic AI in the insurance company's operations had a positive impact. Implementing an agent system helps strengthen the company's competitive position and supports digitalization. There is potential for expanding the research not only to other insurance industries but also to client segments and sales channels. Using an agent system in insurance companies' operations enables decision-making and improves the accuracy of client behavior.

Sales conversion rates and customer retention rates increased, while average application processing time, customer acquisition costs, and operator workload decreased. A limitation of the study is that Agentic AI is only applicable to one type of insurance product. Given technological advances, we anticipate further automation and digitalization. Further research in this area could include implementing new algorithms into the autonomous system and expanding its functionality. The agent system could also be integrated with other digital tools.

Список источников

1. Белова С.Д. Цифровые технологии на рынке страховых услуг Российской Федерации: проблемы и перспективы в период пандемии COVID-19 // НАУКОСФЕРА. 2022. № 2-1. С. 162–165. URL: https://www.elibrary.ru/item.asp?id=48224065 (дата обращения: 28.11.2025)
2. Какалыева Ч.Н., Розмурадова Дж. Влияние искусственного интеллекта на развитие страховой отрасли // Вестник науки. 2024. № 9 (78). С. 24–27. URL: https://cyberleninka.ru/article/n/vliyanie-iskusstvennogo-intellekta-na-razvitie-strahovoy-otrasli (дата обращения: 28.11.2025).
3. Сабитов К.Т., Исаев Д.В. Возможности искусственного интеллекта в страховании // Научный сетевой журнал «Столыпинский вестник». 2024. № 9. [Электронный ресурс]. URL: https://cyberleninka.ru/article/n/vozmozhnosti-iskusstvennogo-intellekta-v-strahovanii (дата обращения: 26.11.2025)
4. Петрова Л.А. Цифровые технологии в экономике и бизнесе // ЦИФРОВАЯ ЭКОНОМИКА. 2020. С. 74–89. [Электронный ресурс]. URL: https://cyberleninka.ru/article/n/tsifrovye-tehnologii-v-ekonomike-i-biznese (дата обращения: 26.11.2025)
5. Брызгалов Д.В., Грызенкова Ю.В., Цыганов А.А. Перспективы цифровизации страхового дела в России // Финансовый журнал. 2020. Т. 12, № 3. С. 76–90. DOI: 10.31107/2075-1990-2020-3-76-90. URL: https://elib.sfu-kras.ru/handle/2311/129923?show=full.sfu-kras.ru/handle/2311/129923?show=full (дата обращения: 28.11.2025).
6. Жилкина А.Н. Страхование как объект управления инновационным развитием // Проблемы современной экономики. 2012. № 1. С. 444–446. [Электронный ресурс]. URL: https://elibrary.ru/item.asp?id=17924768 (дата обращения: 26.11.2025)
7. Захарова Т.И., Иванов А.А., Кокоулина О.П., Халиль И.А., Цимбалюк А.А. Сущность концепции управления взаимоотношениями с клиентами (CRM-системы) и ее роль в повышении эффективности деятельности в современных организациях // Инновации и инвестиции. 2021. № 6. [Электронный ресурс]. URL: https://cyberleninka.ru/article/n/suschnost-kontseptsii-upravleniya-vzaimootnosheniyami-s-klientami-crm-sistemy-i-ee-rol-v-povyshenii-effektivnosti-deyatelnosti-v
8. Белова А.О. Экономическая эффективность внедрения CRM-систем: анализ преимуществ и показателей // Актуальные исследования. 2025. № 6 (241). С. 45-53. [Электронный ресурс]. URL: https://apni.ru/article/11314-ekonomicheskaya-effektivnost-vnedreniya-crm-sistem-analiz-preimushestv-i-pokazatelej (дата обращения: 27.11.2025)
9. Ivens B., Kasper-Brauer K., Leischnig A., Thornton S. Implementing customer relationship management successfully: A configurational perspective // Technological Forecasting & Social Change. 2023. Vol. 192. Article 122367. DOI: 10.1016/j.techfore.2023.122367 [Электронный ресурс]. — URL: https://www.sciencedirect.com/science/article/abs/pii/S0040162523007680

References

1. Belova S.D. Tsifrovye tekhnologii na rynke strakhovykh uslug Rossiiskoi Federatsii: problemy i perspektivy v period pandemii COVID-19. NAUKOSFERA. 2022. № 2-1. S. 162–165. URL: https://www.elibrary.ru/item.asp?id=48224065 (data obrashcheniya: 28.11.2025)
2. Kakalyeva CH.N., Rozmuradova Dzh. Vliyanie iskusstvennogo intellekta na razvitie strakhovoi otrasli. Vestnik nauki. 2024. № 9 (78). S. 24–27. URL: https://cyberleninka.ru/article/n/vliyanie-iskusstvennogo-intellekta-na-razvitie-strahovoy-otrasli (data obrashcheniya: 28.11.2025).
3. Sabitov K.T., Isaev D.V. Vozmozhnosti iskusstvennogo intellekta v strakhovanii. Nauchnyi setevoi zhurnal «Stolypinskii vestniK». 2024. № 9. [Ehlektronnyi resurs]. URL: https://cyberleninka.ru/article/n/vozmozhnosti-iskusstvennogo-intellekta-v-strahovanii (data obrashcheniya: 26.11.2025)
4. Petrova L.A. Tsifrovye tekhnologii v ehkonomike i biznese. TSIFROVAYA EHKONOMIKA. 2020. S. 74–89. [Ehlektronnyi resurs]. URL: https://cyberleninka.ru/article/n/tsifrovye-tehnologii-v-ekonomike-i-biznese (data obrashcheniya: 26.11.2025)
5. Bryzgalov D.V., Gryzenkova YU.V., Tsyganov A.A. Perspektivy tsifrovizatsii strakhovogo dela v Rossii. Finansovyi zhurnal. 2020. T. 12, № 3. S. 76–90. DOI: 10.31107/2075-1990-2020-3-76-90. URL: https://elib.sfu-kras.ru/handle/2311/129923?show=full.sfu-kras.ru/handle/2311/129923?show=full (data obrashcheniya: 28.11.2025).
6. Zhilkina A.N. Strakhovanie kak ob"ekt upravleniya innovatsionnym razvitiem. Problemy sovremennoi ehkonomiki. 2012. № 1. S. 444–446. [Ehlektronnyi resurs]. URL: https://elibrary.ru/item.asp?id=17924768 (data obrashcheniya: 26.11.2025)
7. Zakharova T.I., Ivanov A.A., Kokoulina O.P., Khalil' I.A., Tsimbalyuk A.A. Sushchnost' kontseptsii upravleniya vzaimootnosheniyami s klientami (CRM-sistemy) i ee rol' v povyshenii ehffektivnosti deyatel'nosti v sovremennykh organizatsiyakh. Innovatsii i investitsii. 2021. № 6. [Ehlektronnyi resurs]. URL: https://cyberleninka.ru/article/n/suschnost-kontseptsii-upravleniya-vzaimootnosheniyami-s-klientami-crm-sistemy-i-ee-rol-v-povyshenii-effektivnosti-deyatelnosti-v
8. Belova A.O. Ehkonomicheskaya ehffektivnost' vnedreniya CRM-sistem: analiz preimushchestv i pokazatelei. Aktual'nye issledovaniya. 2025. № 6 (241). S. 45-53. [Ehlektronnyi resurs]. URL: https://apni.ru/article/11314-ekonomicheskaya-effektivnost-vnedreniya-crm-sistem-analiz-preimushestv-i-pokazatelej (data obrashcheniya: 27.11.2025)
9. Ivens B., Kasper-Brauer K., Leischnig A., Thornton S. Implementing customer relationship management successfully: A configurational perspective. Technological Forecasting & Social Change. 2023. Vol. 192. Article 122367. DOI: 10.1016/j.techfore.2023.122367 [Ehlektronnyi resurs]. URL: https://www.sciencedirect.com/science/article/abs/pii/S0040162523007680

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Contribution of the authors:
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Новый взгляд на волны сжатия в солнечной короне

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Аннотация. ***Введение.*** До настоящего времени не выяснена природа волн сжатия, наблюдаемых в солнечной короне в крайнем ультрафиолетовом диапазоне. Устоявшийся подход, связанный с проблемой нагрева корональной плазмы, основан на представлении о магнитоакустических волнах, генерируемых в нижних слоях атмосферы. Однако многочисленные наблюдения и анализ спектров волн сжатия показывают признаки, существенно отличающиеся от свойств обычных волн. ***Результаты и обсуждения.*** Нами предложена новая модель, в которой вместо регулярной волны рассматривается последовательность отдельных локализованных возмущений. ***Заключение*** Практическая значимость статьи, основанной на свойствах акустических волн, на динамику которых значительное влияние оказывают теплопроводность и излучение плазмы, что позволило показать, что наблюдаемые признаки можно объяснить на совершенно иной основе. Мы полагаем, что в действительности наблюдаются цепочки локализованных возмущений, генерируемых в нижней атмосфере.

Ключевые слова: Компьютерное моделирование, физика плазмы, функция излучения, магнитная гидродинамика, Солнце, колебания и волны.

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Research article

A new sight at compressive waves in the solar corona

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Abstract. ***Introduction.*** To date, the nature of the compression waves observed in the solar corona in the extreme ultraviolet range has not been clarified. The established approach to the problem of heating the coronal plasma is based on the concept of magnetoacoustic waves generated in the lower layers of the atmosphere. However, numerous observations and analyses of the spectra of compression waves show features that differ significantly from those of conventional waves. ***Results and discussions***. We have proposed a new model that considers a sequence of individual localized disturbances instead of a regular wave. ***Conclusion*** The practical significance of the article is based on the properties of acoustic waves, the dynamics of which are significantly influenced by the thermal conductivity and radiation of the plasma, which has shown that the observed features can be explained on a completely different basis. We believe that what is actually observed are chains of localized disturbances generated in the lower atmosphere.

Key words: Computer modeling, plasma physics, radiation function, magnetic hydrodynamics, Sun, oscillations, and waves.

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Introduction

For several decades, propagating variations in the intensity of extreme ultraviolet radiation have been observed in the solar corona, which are interpreted as compression waves. Along with the intensity change, a Doppler shift is sometimes observed, indicating plasma motion. Disturbances propagate along coronal structures, coronal loops [1,2] and coronal holes [3-6]. The spectra of time signals are usually broad, and dominant maxima, declared to be periods, are sought in the wavelet spectra (Fig. 1). Most often, two maxima are observed; they are called short and long periods. The short one lies on average in the interval of up to 10 min, the long one - in the interval of 10-30 min. Disturbances quickly attenuate, demonstrating a frequency dependence [3,4], disturbances with periods of 3-5 min are observed up to distances of 3-23 Mm, with periods of 20-30 min - up to 70-90 Mm.

An example of a wavelet spectrum is shown in Figure 1. Two maxima are prominent in the global spectrum. Analysis of multiple events allowed us to make the following observations. It is difficult to determine from the appearance of the time signal whether it is harmonic or a superposition of harmonic components. It contains sharp spikes with a broad spectrum. The main maximum of 20 minutes has a limited duration in the local spectrum, which also contains other

maxima. The period registration is irregular, and the disturbances typically have a low propagation velocity, almost always significantly lower than the speed of sound. These characteristic features of compression waves require some explanation.

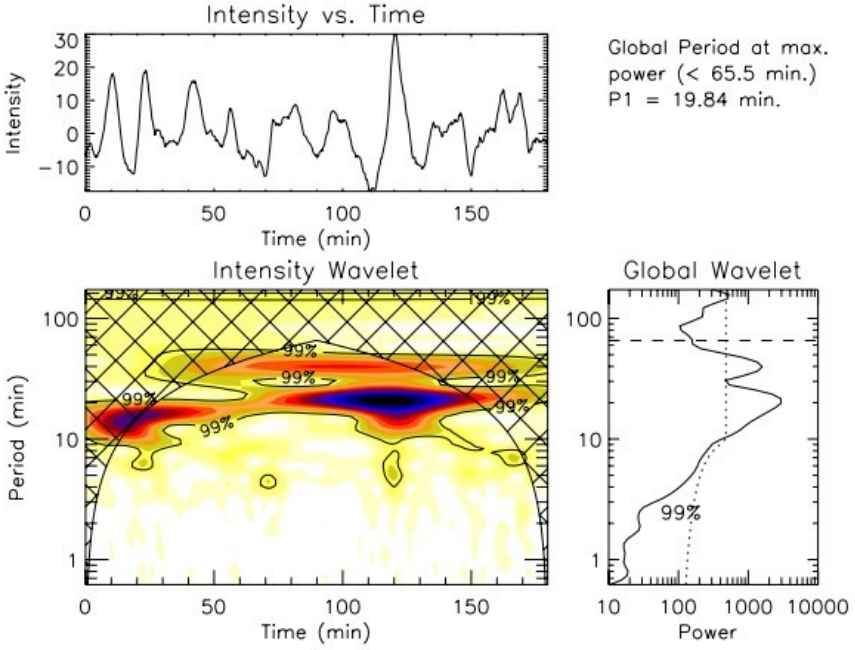

Figure 1- A typical observation of a compression wave and its wavelet spectrum. The grid highlights the region of the spectrum beyond the cone of influence, where the data is considered unreliable. The global spectrum shows two maxima, one of which has a period of approximately 20 minutes.

Nonadiabatic acoustic waves

To study compression waves, we employ the apparatus of nonadiabatic acoustic waves, whose behavior is influenced by thermal conductivity, heating, and radiation from the coronal plasma. Calculations are performed in the one-dimensional hydrodynamics approximation, and the dispersion equation has the form [7, 8]

$$\tilde{\omega}^3 + iA\tilde{\omega}^2 - \tilde{\omega}\tilde{C}_s^2\tilde{k}^2 + iB = 0, \quad (1)$$

$$A = A_1\tilde{k}^2 + A_2, B = \frac{1}{\gamma}\left(-A_1\tilde{k}^2 - A_2 + A_3\right)\tilde{C}_s^2\tilde{k}^2, \quad (2)$$

its coefficients are determined through the thermal conductivity coefficient $\varkappa(T_0)$and the radiation function$\Lambda(T_0)$

$$A_1 = \frac{(\gamma-1)Mm(k)^2}{R\rho_0 m(\omega)}\varkappa(T_0),$$
$$A_2 = \frac{(\gamma-1)M}{Rm(\omega)}\rho_0\Lambda'(T_0), \quad (3)$$
$$A_3 = \frac{(\gamma-1)M}{RT_0 m(\omega)}\rho_0\Lambda(T_0).$$

The tilde here denotes dimensionless quantities; the following scales were chosen for the solar corona conditions

$$m(T) = 10^6\ K, m(C_s) = 10^5\ \text{м с}^{-1}, m(\omega) = 0.1\ \text{с}^{-1}, m(k) = 10^{-6}\ \text{м}^{-1}, \quad (4)$$
$$m(x) = 10^6\ \text{м}, m(t) = 10\ \text{с}.\ m(\Lambda) = 10^{26}\ \text{эрг г}^{-2}\ \text{см}^3\ \text{с}^{-1}.$$

The plasma is described by the equation of state of an ideal gas, where $\gamma = 5/3$, is the molar mass $M = 0.62 \times 10^{-3}\ kg\ mol^{-1}$.. The radiation function is determined by cubic splines over a series of values found numerically [7]. For a fully ionized plasma, the thermal conductivity coefficient is determined by the expression

$$\varkappa(T_0) = 2.28 \times 10^{-11}\ T_0^{5/2}\ (\text{Вт м}^{-1}\ \text{К}^{-1}). \quad (5)$$

Figure 2 shows the dependence of the group velocity on the period and the attenuation length. The group velocity has two minima $P_1$and P_2, at a temperature of 1 MK they are equal to

5.04 and 68.4 min. The first of these is due to thermal conductivity, the second to heating and radiation. The first is important for us, as it divides the periods into short ($P < P_1$) and long ($P > P_1$). Short-period waves have weak dispersion and strong attenuation, while long-period waves, on the contrary, have strong dispersion and weak attenuation. We have thus obtained a relationship between the minimum group velocity and the properties of dispersion and attenuation. To confirm this, we present the asymptotic values of the wave number

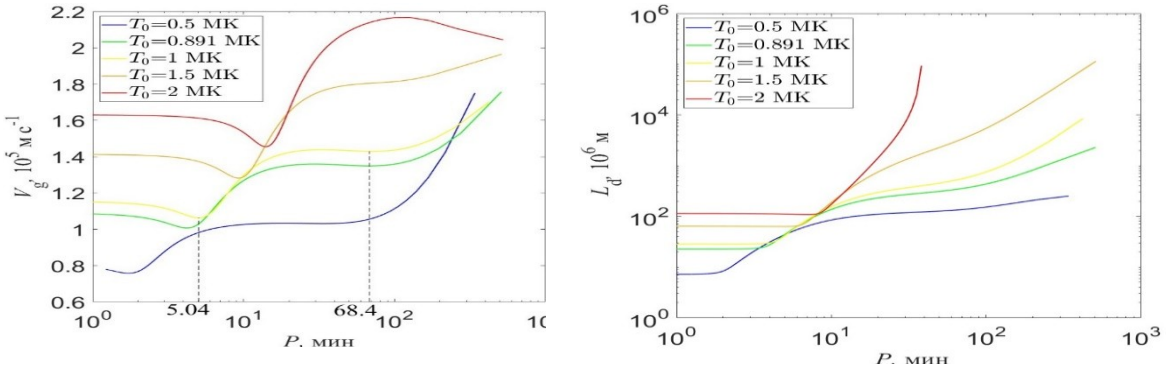

Figure 2 - Properties of dispersion and attenuation of an acoustic wave. On the left, the dependence on the group velocity period; on the right, the dependence on the attenuation coefficient length.

$$\tilde{k} \approx \frac{\sqrt{\gamma}\tilde{\omega}}{\tilde{C}_s}\left(1 + \frac{S_1}{\tilde{\omega}^2} + \mathcal{O}(\tilde{\omega}^{-4})\right) + \frac{i(\gamma-1)\tilde{C}_s}{2\sqrt{\gamma}B_1}\left(1 + \frac{S_2}{\tilde{\omega}^2} + \mathcal{O}(\tilde{\omega}^{-4})\right), \tilde{\omega} \to \infty, \quad (6)$$

$$S_1 = \frac{\tilde{n}_0^2 C_s^2}{\gamma}\left(\frac{(\gamma-1)(5-\gamma)\tilde{C}_s^2}{8\gamma B_1^2} - \frac{B_3}{2B_1}\right), S_2 = \frac{\tilde{n}_0^2\tilde{C}_s^2(B_3 - B_2)}{2(\gamma-1)B_1}, \quad (7)$$

fair provided

$$\tilde{P} \ll \tilde{P}_c = \frac{\pi\gamma\sqrt{\gamma}B_1}{2\tilde{n}_0\tilde{C}_s^2}. \quad (8)$$

It turns out that , $P_c \approx P_1$, so the asymptotics allow us to determine the applicability limits of the short- and long-period approximations. According to Figure 2, the attenuation length $L_\mathrm{d} = 1/\mathrm{Im}k$for short periods takes on a practically constant value.

$$L_\mathrm{d} \approx L_{\mathrm{d}0} = 2.87 \cdot 10^4 \frac{T_0^2}{n_0}\ (\text{Мм}), P < P_1. \quad (9)$$

Modeling of wave packets

Let's consider the behavior of an initial pulsed acoustic disturbance. We assume that it originates in the lower atmosphere and propagates upward into the corona. The disturbance is represented by a Fourier integral.

$$\rho = \varepsilon\rho_0 \int_0^{k_\mathrm{max}} F(k)e^{-\delta(k)t}\cos(kx - \omega(k)t)dk, \quad (10)$$

where $k_{\ \mathrm{max}}$ is the maximum wave number that determines the width of the spectrum. The function$\omega(k)$ is found by numerically solving equation (1)-(3). For the spectral density, we choose a Gaussian form . $F(k) = e^{-d^2k^2/4}$The parameter d is the length of the initial pulse, its duration $d/\bar{V}_\mathrm{ph}$is $V_{\ \mathrm{ph}}$ is the average phase velocity in the interval $0 < k < k_\mathrm{max}$. The wave packet disperses and decays, and the expression under the integral $F(k)e^{-\delta(k)t}$can be considered as a local spectral function at the current moment in time. The presence of a minimum in the

group velocity leads to the formation of quasi-periodic oscillations [9]. Depending on the dispersion properties, wavelet spectra shaped like a tadpole or boomerang can form [10,11]. In our case, this is impossible due to the rapid attenuation of the waves.

In our case, the wavelet spectrum has the shape of two separated maxima, which give rise to short and long periods. The formation of the periods is shown in Figure 3 based on the dispersion and attenuation properties of acoustic waves. The solid and dashed blue lines show the initial perturbation spectrum for two different values of length d (left figure). The solid and dashed yellow lines show the same spectra at a certain moment. t_0.At the minimum of the group velocity P_1 the spectral function experiences a dip due to uneven attenuation. Two groups of waves with different periods P_s are formed on either side of the minimum and P_l , but the same speed (right figure). The long period is close to P_{m}, this is the boundary of the periods when such pairs are possible.

Thus, instead of a single initial Gaussian packet, two separate wave packets are obtained, one formed by short-period waves, the other by long-period ones. To confirm this, we conducted a wavelet analysis of time signals recorded at specified distances from the source (Fig. 4). The appearance of the signals themselves shows that the initial Gaussian signal has split into two signals, narrow and wide. Figure 5 shows their wavelet spectra, constructed using the Morlet wavelet using the Torrance-Compeau algorithm [12]. Indeed, in addition to one maximum characteristic of a quasi-Gaussian signal, we see a second maximum located in the region of long periods. Over time, this maximum becomes the dominant one, and the initial short-period signal disappears due to the rapid attenuation of the short-period components.

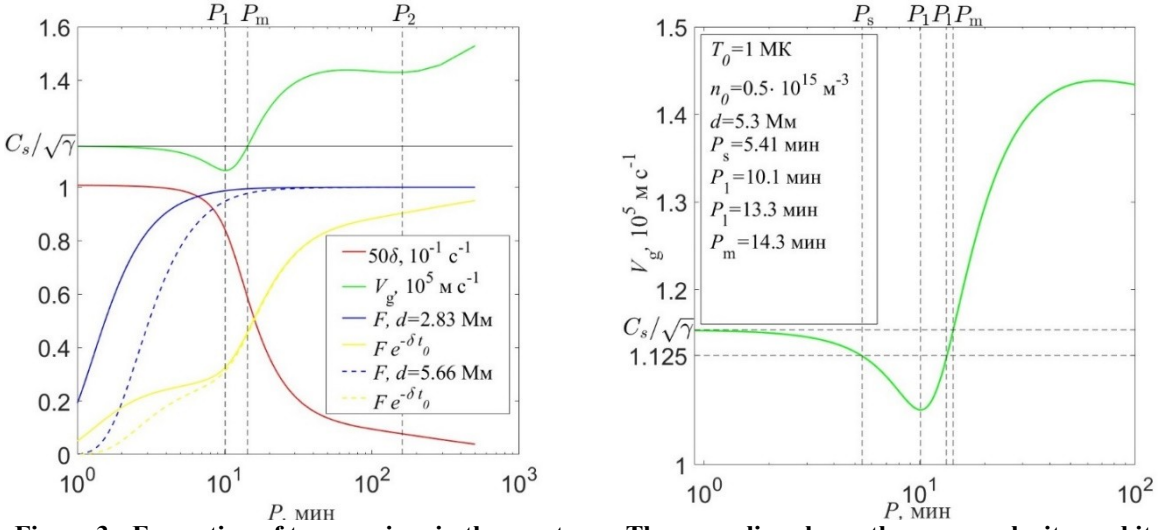

Figure 3 - Formation of two maxima in the spectrum. The green line shows the group velocity, and its minimum is marked P_1. The red line shows the attenuation coefficient, and the blue and yellow lines show the spectral densities at the initial and current moments of time .

At a distance of 58 Mm, the maxima have values of 5.11 and 13.3 min at $T_0 = 1\text{MK}$, $n_0 = 0.45 \cdot 10^{15}\text{m}^{-3}$, they are well within the range of observed values.

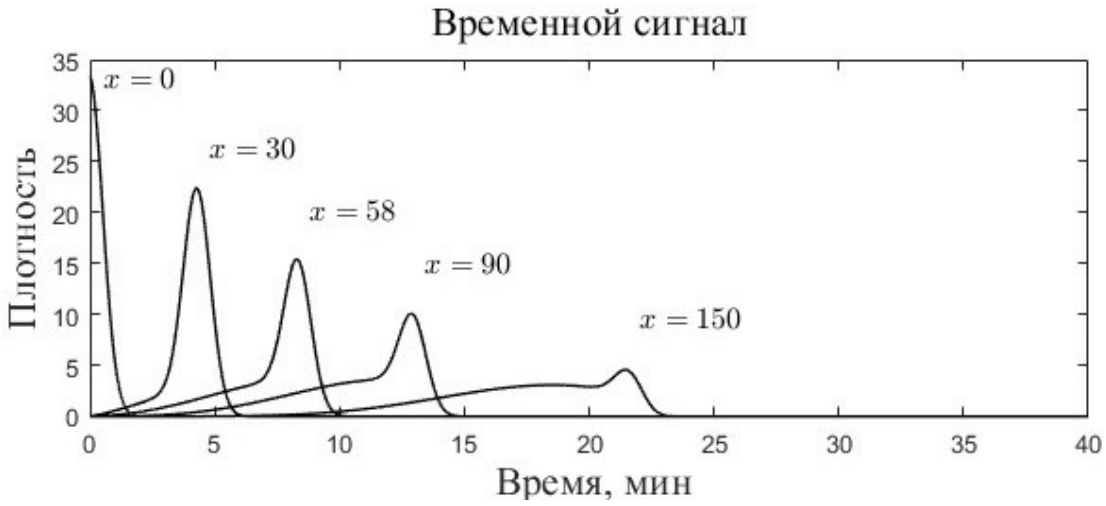

Figure 4 - *x*The time signal generated by a wave packet at a given distance x from the source .

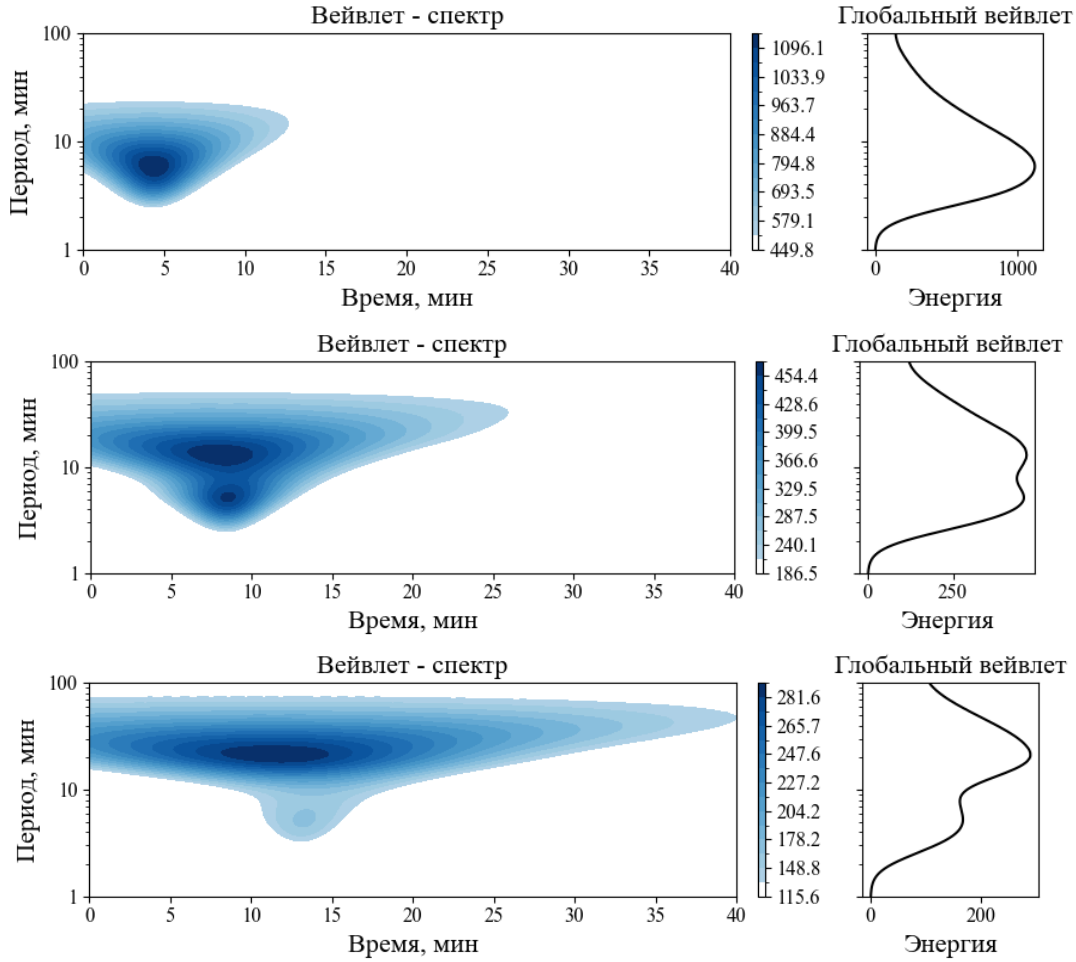

Figure 5 -Wavelet spectrum of signals generated by a wave packet at distances x=30 mm, 58 mm, 90 mm from the source. Plasma parameters: T_0=1 MK, n_0= 〖0.45·10〗 ^15 m-3. The initial pulse length is d = 5.3 mm.

Conclusion

Studying the dispersion and attenuation properties of acoustic waves in the solar corona's plasma allows for a new interpretation of the nature of compression waves, which are ubiquitous in the corona and are crucial for solving fundamental problems in heliophysics. Each spike in the recorded time signals of extreme ultraviolet radiation intensity can be viewed as a reflection of a

localized disturbance generated in the lower atmosphere and then propagated into the corona. Under the influence of dispersion and attenuation, which have a specific nature, each localized initial disturbance is transformed into a signal with two clearly defined periods in its spectrum. The observed so-called compression waves represent a chain of such disturbances, generated independently of one another and having different periods. This approach immediately explains the first two characteristics of compression waves. The disturbances propagate with a velocity close to the group velocity, which is always less than the phase velocity. This also explains the third characteristic.

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Список источников

1. Bergmans D., Clette F. Active region EUV transient brightenings–First Results by EIT of SOHO JOP 80. Solar Physics. 1999. Vol. 186. P. 207-229. https://doi.org/10.1023/A:1005189508371.
2. De Moortel I. Longitudinal Waves in Coronal Loops. Space Science Reviews. 2009. Vol. 149. P. 65-81. DOI: 10.1007/s11214-009-9526-5.
3. Gupta G.R., Teriaca L., Marsch E., et al. Spectroscopic observations of propagating disturbances in a polar coronal hole: evidence of slow magneto-acoustic waves**.** Astronomy and Astrophysics. 2012. Vol. 546. A93. https://doi.org/10.1051/0004-6361/201219795.
4. Krishna Prasad S., Banerjee D., Van Doorsselaere T. Frequency-dependent damping in propagating slow magneto-acoustic waves. The Astrophysical Journal. 2014. Vol. 789. № 2. 118. https://doi.org/10.1088/0004-637X/789/2/118.
5. Banerjee D., Gupta G.R., Teriaca L. Propagating MHD Waves in Coronal Holes. Space Science Reviews. 2011. Vol. 158. P. 267-288. https://doi.org/10.1007/s11214-010-9698-z
6. Banerjee D., Krishna Prasad S., Pant V., et al. Magnetohydrodynamic Waves in Open Coronal Structures. Space Science Reviews. 2021. Vol. 217. 76. https://doi.org/10.1007/s11214-021-00849-0.
7. Derteev S., Shividov N., Bembitov D., et al. Damping and Dispersion of Non-Adiabatic Acoustic Waves in a High-Temperature Plasma: A Radiative-Loss Function. Physics. 2023. Vol. 5. P. 215-228. https://doi.org/10.3390/physics5010017.
8. Mikhalyaev B.B., Derteev S.B., Shividov N.K., et al. Acoustic Waves in a High-Temperature Plasma II. Damping and Instability. Solar Physics. 2023. Vol. 298. 102. https://doi.org/10.1007/s11207-023-02196-5.
9. Roberts R. MHD Waves in the Solar Atmosphere. University Printing House, Cambridge, 2019. https://doi.org/10.1017/9781108613774
10. Nakariakov V.M., Pascoe D.J., Arber T.D. Short Quasi-Periodic MHD Waves in Coronal Structures. Space Science Reviews. 2005. Vol. 121. P. 115-125. https://doi.org/10.1007/s11214-006-4718-8.
11. Kolotkov D.Y., Nakariakov V.M., Moss G., et al. Fast magnetoacoustic wave trains: from tadpoles to boomerangs. Monthly Notices of the Royal Astronomical Society. 2021. Vol. 505, P. 3505-3513. https://doi.org/10.1093/mnras/stab1587.
12. Torrence C., Compo, G.P. A practical guide to wavelet analysis. Bulletin of the American Meteorological Society. 1998. Vol. 79. Issue 1. P. 61-78. https://doi.org/10.1175/1520-0477(1998)079<0061:APGTWA>2.0.CO;2.

References

1. Bergmans D., Clette F. Active region EUV transient brightenings–First Results by EIT of SOHO JOP 80. Solar Physics. 1999. Vol. 186. P. 207-229. https://doi.org/10.1023/A:1005189508371.
2. De Moortel I. Longitudinal Waves in Coronal Loops. Space Science Reviews. 2009. Vol. 149. P. 65-81. DOI: 10.1007/s11214-009-9526-5.

3. Gupta G.R., Teriaca L., Marsch E., et al. Spectroscopic observations of propagating disturbances in a polar coronal hole: evidence of slow magneto-acoustic waves**.** Astronomy and Astrophysics. 2012. Vol. 546. A93. https://doi.org/10.1051/0004-6361/201219795.
4. Krishna Prasad S., Banerjee D., Van Doorsselaere T. Frequency-dependent damping in propagating slow magneto-acoustic waves. The Astrophysical Journal. 2014. Vol. 789. № 2. 118. https://doi.org/10.1088/0004-637X/789/2/118.
5. Banerjee D., Gupta G.R., Teriaca L. Propagating MHD Waves in Coronal Holes. Space Science Reviews. 2011. Vol. 158. P. 267-288. https://doi.org/10.1007/s11214-010-9698-z
6. Banerjee D., Krishna Prasad S., Pant V., et al. Magnetohydrodynamic Waves in Open Coronal Structures. Space Science Reviews. 2021. Vol. 217. 76. https://doi.org/10.1007/s11214-021-00849-0.
7. Derteev S., Shividov N., Bembitov D., et al. Damping and Dispersion of Non-Adiabatic Acoustic Waves in a High-Temperature Plasma: A Radiative-Loss Function. Physics. 2023. Vol. 5. P. 215-228. https://doi.org/10.3390/physics5010017.
8. Mikhalyaev B.B., Derteev S.B., Shividov N.K., et al. Acoustic Waves in a High-Temperature Plasma II. Damping and Instability. Solar Physics. 2023. Vol. 298. 102. https://doi.org/10.1007/s11207-023-02196-5.
9. Roberts R. MHD Waves in the Solar Atmosphere. University Printing House, Cambridge, 2019. https://doi.org/10.1017/9781108613774
10. Nakariakov V.M., Pascoe D.J., Arber T.D. Short Quasi-Periodic MHD Waves in Coronal Structures. Space Science Reviews. 2005. Vol. 121. P. 115-125. https://doi.org/10.1007/s11214-006-4718-8.
11. Kolotkov D.Y., Nakariakov V.M., Moss G., et al. Fast magnetoacoustic wave trains: from tadpoles to boomerangs. Monthly Notices of the Royal Astronomical Society. 2021. Vol. 505, P. 3505-3513. https://doi.org/10.1093/mnras/stab1587.
12. Torrence C., Compo, G.P. A practical guide to wavelet analysis. Bulletin of the American Meteorological Society. 1998. Vol. 79. Issue 1. P. 61-78. https://doi.org/10.1175/1520-0477(1998)079<0061:APGTWA>2.0.CO;2.

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Научная статья
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Математическое моделирование и машинное обучение для оптимизации состава глубоких эвтектических растворителей при извлечении коллагена из костного остатка птицы

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Аннотация. ***Введение.*** В работе рассматривается применение глубоких эвтектических растворителей (DES) для повышения эффективности экстракции коллагена из животного сырья. Актуальность обусловлена необходимостью замены традиционных органических экстрагентов более безопасными и регулируемыми средами, обеспечивающими стабильность белковых структур и снижение экологической нагрузки. ***Цель.*** Цель исследования — выявить оптимальные составы DES, способные обеспечивать высокий выход коллагена при низких температурах и мягких технологических условиях, а также определить дескрипторы, влияющие на экстракционную способность. ***Материалы и методы.*** Анализ выполнен на основе рассчитанных физико-химических дескрипторов компонентов DES и моделирования выходов коллагена с использованием нейросетевой модели MLP. Рассмотрено 120 комбинаций HBA и HBD, охватывающих металлосодержащие и натуральные системы. Данные нормализованы и использованы для построения сравнительной таблицы дескрипторов и прогностических характеристик. ***Результаты и обсуждение.*** Выявлено, что DES, содержащие Lewis-кислоты Zn^{2+} и Sn^{2+}, характеризуются пониженной полярностью и умеренной вязкостью, что обеспечивает максимальный прогнозируемый выход коллагена. Натуральные NADES демонстрируют несколько меньшую эффективность, но обладают преимуществами пищевой безопасности. Построенный бар-чарт визуализирует превосходство металлосодержащих систем по сравнению с классическим контрольным DES. ***Заключение.*** Установлено, что сочетание структурных дескрипторов и машинного обучения позволяет достоверно прогнозировать эффективность DES и минимизировать объём лабораторных испытаний. Металлосодержащие системы являются наиболее перспективными для последующей экспериментальной верификации.

Ключевые слова: Lewis-кислоты, молекулярные дескрипторы, MLP-модель, HBA/HBD-системы, NADES, экстракция коллагена

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Research article

Mathematical Modeling and Machine Learning for Optimizing the Composition of Deep Eutectic Solvents in the Extraction of Collagen from Poultry Bone Residues

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Abstract. ***Introduction.*** This study examines the use of deep eutectic solvents (DESs) to enhance the efficiency of collagen extraction from animal-derived raw materials. The relevance of the work is driven by the need to replace traditional organic extractants with safer and more controllable media that ensure protein structural stability while reducing environmental impact. ***Goal.*** The aim of the research is to identify optimal DES compositions capable of providing high collagen yield at low temperatures and under mild technological conditions, as well as to determine the descriptors influencing extraction performance. ***Materials and methods.*** The analysis is based on calculated physicochemical descriptors of DES components and modeling of collagen yields using a multilayer perceptron (MLP) neural network. A total of 120 combinations of hydrogen bond acceptors (HBAs) and hydrogen bond donors (HBDs), including metal-containing and natural systems, were evaluated. The data were normalized and used to construct a comparative table of descriptors and predictive characteristics. ***Results and discussion.*** DESs containing Lewis acids Zn^{2+} and Sn^{2+} were found to exhibit reduced polarity and moderate viscosity, which together provide the highest predicted collagen yields. Natural NADES showed slightly lower efficiency but offered advantages in terms of food safety. The constructed bar chart visualizes the superiority of metal-containing systems compared to a classical control DES. ***Conclusion.*** It has been established that the combination of structural descriptors and machine learning enables reliable prediction of DES efficiency and minimizes the volume of laboratory testing. Metal-containing systems are the most promising candidates for subsequent experimental verification.

Key words: Deep eutectic solvents., Natural deep eutectic solvents, Molecular descriptors; Machine learning; MLP model; Collagen extraction

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Introduction. Deep eutectic solvents (DES) are a promising class of green chemistry and sustainable biotechnology tools: they are low-toxic, biodegradable, and easily customizable, making them an effective replacement for organic solvents and aggressive alkaline systems in the extraction of proteins and peptides, including collagen and its hydrolysates [1]. Compared to first-generation ionic liquids (ILs), DES are characterized by a significantly lower cost (≈45-450 ₽/kg versus 4,500-45,000 ₽/kg), a high degree of biodegradation (up to 97% in 28 days according to OECD 301), and the absence of toxic halides, which ensures their compliance with the requirements of the food and pharmaceutical industries [2].

The use of DES in the extraction of proteins and peptides, including collagen, provides a yield of 78-96% while preserving native functional properties. In plant matrices, ChCl-glycerol (1:2) gives a protein yield of 85-93% with a purity of >90% and superior emulsifying properties compared to alkaline extraction [3, 4]. For animal raw materials (fish skin, pig skins, chicken feet), DES based on choline chloride and organic acids selectively extract collagen peptides weighing 2-8 kDa with a Gly-Pro-Hyp content of up to 18%, destroying cross-links without denaturing the triple helix under mild conditions (40-60 °C, pH 4-6) [5, 6]. Two-phase ChCl-sorbitol-water systems ensure the fractionation of collagen and lipids with a peptide yield of >90% and preservation of antioxidant activity [7]. DES recycling reaches 85-92% after 4-5 cycles of vacuum distillation without reducing the extraction efficiency [8].

Mathematical modeling is a key tool in biotechnology, enabling process optimization, reduced experimental costs, and increased accuracy in predicting the solubility of proteins and peptides and the yield of biologically active substances from secondary raw materials [9]. Deterministic models based on kinetic equations and mass balances are limited in describing the nonlinear and stochastic interactions characteristic of complex biosystems [10]. From 2015 to 2025, machine learning methods, including regression approaches and neural networks that integrate multivariate experimental and structural data and generate highly accurate empirical models, have assumed a leading role [11].

Neural networks (NNs) and deep learning methods are key tools for analyzing biotechnological data, enabling the identification of hidden dependencies and significantly reducing the volume of laboratory experiments [12]. The main architectures—multilayer perceptrons (MLPs), convolutional networks (CNNs), and graph networks (GNNs)—provide high accuracy in predicting protein and peptide solubility by taking into account sequence, structural, and topological features of molecules [13]. MLPs effectively solve regression problems on sets of physicochemical descriptors, achieving $R^2 > 0.85$ and RMSE 0.30–0.50 log S, while interpretation via SHAP allows for determining the contribution of key motifs, such as Gly-Pro-Hyp [14–16]. Convolutional neural networks (CNNs) are used for contact map and time series analysis, demonstrating high accuracy (AUC 0.88–0.92) when working with large sequential datasets and generating synthetic data via GANs to improve models when training examples are scarce [17–21]. GNNs take into account the topology and 3D geometry of molecules, achieving R^2 of 0.90–0.95 when predicting collagen peptide properties and demonstrating advantages for small datasets when combined with transfer learning [22–26]. Together, these approaches provide prediction accuracy of 85–98% [27].

Materials and methods of research. The components for the synthesis of DES were selected based on the criteria of biocompatibility, food safety and biodegradability in accordance with the principles of green chemistry [28, 29]. Choline chloride was used as HBA, and glycerol, urea and organic acids, providing optimal parameters of the medium during collagen extraction, were used as HBD [30-33]. NADES were formed on the basis of natural amino acids and betaine [34], and Zn^{2+} and Sn^{2+} salts acted as Lewis acids, promoting increased decalcification efficiency [35, 36]. The reagents (≥99%) were stored in a desiccator with humidity control using the Karl Fischer method (≤0.1% by weight).

DES was synthesized by heating the component mixtures at 80 ± 2 °C until a homogeneous solution was obtained; physicochemical parameters were determined using standard methods [37]. Molecular descriptors were calculated using RDKit and SwissADME based on PubChem, ChEMBL, ChemSpider, and CompTox data. All computational procedures were performed in Python 3.11 using the RDKit, scikit-learn, PyTorch, and XGBoost libraries.

To model collagen yield, a simulated dataset (n = 1240) was generated. It was based on the physicochemical properties of DES extraction systems and calibrated using 38 literature points (2017-2024). The dataset structure included 18 input variables and one target variable—collagen yield. The response was modeled using Gaussian, logistic, and concentration dependencies, taking into account the effect of Zn^{2+}/Sn^{2+}; the resulting values were limited to

a range of 45-92%. Generation was performed in Python (NumPy, Pandas) with a fixed seed of 42; the corresponding code is available in an open repository.

Two collagen yield prediction models were developed: Ridge multiple linear regression and MLP neural network. After removing correlated features, 28 descriptors were used; normalization was performed using StandardScaler (Ridge) and MinMaxScaler (MLP). The dataset was divided into training, validation, and test sets (70%/15%/15%); external evaluation was performed on 38 independent literature datasets.

Model validation included stratified partitioning, k-fold cross-validation (10-fold for Ridge, 5-fold for MLP), external evaluation, and Applicability Domain analysis.

Research results and discussion. The study was based on a series of highly controlled syntheses of DES and NADES, performed using high-purity reagents (≥99%), which ensured the stability of the physicochemical properties of the starting components and the reproducibility of the model systems. Strict control of the reactant humidity and the elimination of hygroscopically bound water eliminated its influence on the melting point, viscosity, and stability of eutectic mixtures—parameters critical for the subsequent calculation of descriptors and the construction of predictive models. The resulting systems covered a wide range of HBA and HBD components, including choline chloride, organic acids, and natural metabolites, ensuring variability in the acid-base properties, hydrogen donor-acceptor balance, and structural organization of DES. Based on these characteristics, an array of molecular descriptors was generated, calculated using open chemical databases and confirmed using RDKit and SwissADME computational methods. These descriptors, supplemented with process parameters, formed the basis of a training set for machine learning models designed to predict collagen yield during DES extraction.

The calculated physicochemical descriptors of the key DES components served as the basis for the feature space used to train the machine learning models. These parameters reflected both molecular polarity and hydrogen bonding ability, as well as the steric and donor-acceptor interactions in HBA/HBD pairs, which determine the stability and solvent properties of DES. Analysis of the descriptors revealed significant variability in the characteristics of the natural components (glycerol, glucose, citric acid) and quaternary ammonium salts, providing a wide range of modeled solvent properties. To more accurately account for the effect of composition on the extraction capacity of DES, the descriptors were averaged according to the molar ratios of the components and normalized before feeding them to the MLP model. Training a hybrid system (linear regression + MLP) allowed us to simulate nonlinear dependences of collagen yield on temperature, pH, concentration, and the HBA:HBD stoichiometry . On the validation set, the prediction accuracy was high (R^2 = 0.91; yield RMSE = 2.8%), confirming the correctness of the selected set of descriptors and the model architecture. The model's predicted parameters demonstrate the advantage of DES systems with Lewis acids Zn^{2+} and Sn^{2+}, which provide higher collagen yield potential due to the coordination of cations with protein carboxyl groups and destabilization of the calcium phosphate phase. Optimal donor-acceptor properties of the HBA/HBD components enhance efficiency. The most promising formulations have a molar ratio of 1:1.5-1:2.0 at 35-40°C, pH 5.0-6.0, and concentrations of 75-90%. The nonlinear MLP model more accurately captures the effects of temperature, pH, and stoichiometry on collagen yield, allowing for the selection of a limited set of DES without losing the reliability of the predictions. Natural NADES systems have demonstrated moderately high yields and are considered promising for food technology due to their GRAS status.

For detailed analysis, Table 1 is provided with the derived DES descriptors including AlogP, TPSA, total hydrogen bonding capacity, predicted polarity, and predicted viscosity.

Table 1 – Derived descriptors for predicting DES extraction capacity

HBA/HBD pair	Averaged AlogP	Average TPSA (Å²)	Total H-binding capacity	Predicted polarity	Expected viscosity
ChCl:Glycerol (1:2)	-2.23	47.21	5	0.82	Average
ChCl:Urea (1:2)	-1.76	52.48	4	0.79	Low
Betaine:Citric acid (1:1.1)	-1.40	86.31	6	0.91	High
ChCl:$ZnCl_2$ (1:1.7)	–2.10*	20.23*	3*	0.75	Medium-high
ChCl:Proline (1:1.8)	-0.53	38.12	4	0.68	Average

(*) taking into account the ionic contribution and equivalent descriptors for Lewis acid salts.

Table 1 shows the intergroup differences: Lewis acid-based systems have low TPSA and increased viscosity, whereas natural pairs, such as betaine:citric acid, have high TPSA and the highest number of donors/acceptors, making them effective for the extraction of hydrophilic peptides.

Thus, Table 1 serves as a tool for the targeted selection of promising DES and comparison of their physicochemical properties with the predicted extraction activity.

Based on the machine learning results, four DES formulations representing different system types (metal-containing , natural, and a classic control) and demonstrating the highest predicted collagen yield were selected from 120 tested HBA and HBD combinations. The selection was conducted taking into account the following criteria: predicted yield >78%, biocompatibility of components, the possibility of obtaining GRAS status, low viscosity (<500 mPa s at 40°C), extraction temperature ≤50°C, and pH 5.0-7.0 to prevent collagen denaturation. The fourth formulation (ChCl-glycerol) was chosen as the control, as it has been the most studied in the literature and allows one to evaluate the effectiveness of traditional DES systems.

For a visual comparison of the predicted activity and physicochemical characteristics of the synthesized DES, a combined table 2 is presented. It includes the component ratio, predicted collagen yield, melting point, viscosity, moisture content, and liquid appearance.

Table 2 – Compositions and physicochemical characteristics of selected DES

No.	DES composition	Ratio of components	Predicted yield, %	Tm, °C	Viscosity 40 °C, mPa s	Humidity, %	Appearance	Note
1	ChCl-$ZnCl_2$	1:1.7	86.4	27.8	308 ± 9	0.06	transparent liquid	Best forecast coordinating metal
2	ChCl-$SnCl_2$	1:1.6	85.1	30.4	295 ± 7	0.05	transparent liquid	Second most effective
3	ChCl-betaine	1:2.0	83.8	17.9	422 ± 12	0.08	transparent liquid	All natural NADES, GRAS
4	ChCl-glycerol	1:2.0	78.2	-17.2	201 ± 6	0.07	transparent liquid	Control, the most studied composition

Analysis of the table shows that metal-containing DES (Nos. 1 and 2) provide the highest predicted collagen yield and are characterized by moderate viscosity and a positive melting point, which facilitates their processing and use. Natural NADES (ChCl-betaine) demonstrates high yield and is GRAS-compliant, but has a slightly higher viscosity, which should be taken into account when scaling up processes. The ChCl-glycerol control composition confirms the baseline efficiency of classical DES and can be used for comparative evaluation.

To visualize the predicted efficacy of the selected formulations, a bar chart was constructed based on MLP model data (Figure 1). The graph demonstrates that metal-containing DESs provide 5-8% higher collagen yield compared to natural systems, while the control formulation maintains the baseline efficacy.

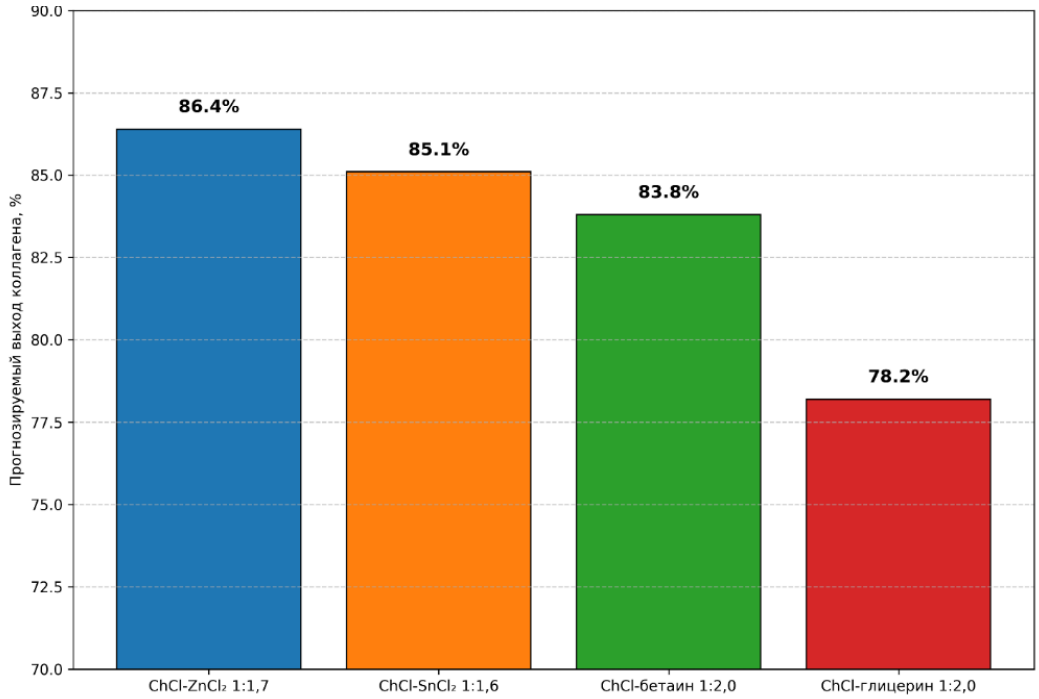

Figure 1 – Predicted collagen yield for selected DES formulations

All four DES were successfully synthesized in quantities of 250-300 g. The physicochemical properties of the synthesized liquids fully matched the MLP model predictions and were within the permissible tolerances (Tm ±6.4%, viscosity ±4.8%). The DES moisture content, determined using the Karl Fischer method, was 0.05-0.08%, which is below the established criterion of ≤0.10% by weight, confirming the effectiveness of the reagent drying measures. The obtained results confirm the adequacy of the MLP model for predicting DES properties and the effectiveness of the composition selection for subsequent experimental verification.

Conclusion. The conducted studies confirmed that the physicochemical parameters of DES and NADES, as well as the composition of HBA/HBD pairs, significantly determine their collagen extraction capacity. Descriptor calculation and modeling revealed wide variability in solvent properties and enabled the formation of an informative feature space for machine learning. The constructed models (Ridge and MLP) reproduced the key nonlinear relationships of collagen yield with temperature, pH, concentration, and component stoichiometry; MLP provided the highest prediction accuracy ($R^2 = 0.91$).

Modeling demonstrated the superiority of DES containing the Lewis acids Zn^{2+} and Sn^{2}, which demonstrate the highest predicted yields (85-86%) due to coordination interactions with protein carboxyl groups and destabilization of the mineral phase of the raw material. Natural NADES provide high yields while maintaining food safety, but are characterized by higher viscosity. The classic ChCl-glycerol composition confirmed the baseline level of efficiency.
The selection of four optimal DES systems demonstrated that metal-containing mixtures retain technological advantages and high parameter stability, while natural compounds can be considered promising alternatives for the food industry. The obtained results confirm the feasibility of targeted DES selection based on computational methods and demonstrate the potential of computer modeling as a tool for preliminary optimization of biopolymer extraction processes.

Список источников

1. Francisco M., van den Bruinhorst A., Kroon M.C. New natural and renewable low transition temperature mixtures (LTTMs): screening as solvents for lignocellulosic biomass processing. Green Chem. 2012. № 14(8). С. 2153–2157.
2. Abbott A.P., Capper G., Davies D.L., Rasheed R.K., Tambyrajah V. Novel solvent properties of choline chloride/urea mixtures. Chem. Commun. 2003. № 1. С. 70–71.
3. Karimi A. et al. Extraction of canola protein via natural deep eutectic solvents compared to alkaline treatments: Isolate characteristics and protein structural and functional properties. Food Hydrocoll. 2024. № 152. С. 109922.
4. Du L. et al. Extraction of protein from sesame meal: Impact of deep eutectic solvents on protein structure and functionality. LWT. 2023. № 187. С. 115345.
5. Bai C., Wei Q., Ren X. Selective extraction of collagen peptides with high purity from cod skins by deep eutectic solvents. ACS Sustain. Chem. Eng. 2017. № 5(6). С. 5476–5484.
6. Tan Y.T. et al. Deep eutectic solvent as an innovative solvent for collagen extraction from marine by-products. J. Food Process. Preserv. 2023. № 47(10). С. e17123.
7. Bhowmik P. et al. Impact of a Novel Two-Phase Natural Deep Eutectic Solvent-Assisted Extraction on the Structural, Functional, and Flavor Properties of Hemp Protein Isolates. Plants. 2025. № 14(2). С. 274.
8. Kudłak B. et al. Application of deep eutectic solvents in protein extraction and purification. Front. Chem. 2022. № 10. С. 912411.
9. Abdipour M., Younessi-Hmazekhanlu M., Ramazani S.H.R., Omidi A. Artificial neural networks and multiple linear regression as potential methods for modeling seed yield of safflower (Carthamus tinctorius L.). Ind. Crops Prod. 2019. № 127. С. 185–194.
10. Niazian M., Sadat-Noori S.A., Abdipour M. Modeling the seed yield of Ajowan (Trachyspermum ammi L.) using artificial neural network and multiple linear regression models. Ind. Crops Prod. 2018. № 117. С. 224–234.
11. Chang C.C., Song J., Tey B.T., Ramanan R.N. Bioinformatics approaches for improved recombinant protein production in Escherichia coli: Protein solubility prediction. Brief. Bioinform. 2014. № 15(6). С. 1047–1059.
12. Rawi R., O'Connell J., Mall R. et al. DeepSol: a deep learning framework for sequence-based protein solubility prediction. Bioinformatics. 2018. № 34(15). С. 2605–2613.
13. Zhou P. Protein engineering in the deep learning era. mLife. 2024. № 3(4). С. 308–325.
14. Wang Y., Zhang L., Li J. et al. Modeling and optimization of collagen hydrolysis process using multilayer perceptron. LWT. 2023. № 175. С. 114489.
15. Chen X., Zhou Y., Wang J. et al. Deep learning prediction of collagen peptide solubility using physicochemical descriptors. J. Food Eng. 2024. № 345. С. 111423.
16. Lundberg S.M., Lee S.-I. A unified approach to interpreting model predictions. Proc. Adv. Neural Inf. Process. Syst. 2017. № 30. С. 4765–4774.
17. Rawi R., Mall R., Kloczkowski A. et al. Deeper profiles and cascaded recurrent and convolutional neural networks for state-of-the-art protein secondary structure prediction. Sci. Rep. 2019. № 9. С. 12374.
18. Wang H., Li Y., Zhang Z. Structure-aware protein solubility prediction from sequence through graph convolutional network and predicted contact map. Bioinformatics. 2021. № 37(5). С. 640–647.
19. Pappu S.M.J., Gummadi S.N. Artificial neural network and regression coupled genetic algorithm to optimize parameters for enhanced xylitol production by Debaryomyces nepalensis in bioreactor. Biochem. Eng. J. 2017. № 120. С. 136–145.
20. Goodfellow I., Pouget-Abadie J., Mirza M. et al. Generative adversarial nets. Proc. Adv. Neural Inf. Process. Syst. 2014. № 27. С. 2672–2680.
21. Alanazi W., Meng D., Pollastri G. DeepPredict: a state-of-the-art web server for protein secondary structure and relative solvent accessibility prediction. Front. Bioinform. 2025. № 5. С. 1607402.
22. Scarselli F., Gori M., Tsoi A.C. et al. The graph neural network model. IEEE Trans. Neural Netw. 2009. № 20(1). С. 61–80.
23. Lee S., Lee M., Gyak K.-W. et al. Novel solubility prediction models: molecular fingerprints and physicochemical features vs graph convolutional neural networks. ACS Omega. 2022. № 7(14). С. 12268–12277.

24. Ahmad W., Tayara H., Shim H.J., Chong K.T. SolPredictor: predicting solubility with residual gated graph neural network. Int. J. Mol. Sci. 2024. № 25(2). C. 715.
25. Tan Y.T., Khoo C.H., Chong K.L. et al. Graph neural networks for biodiesel yield prediction in lignocellulosic biorefineries. Renew. Energy. 2025. № 215. C. 119012.
26. Rives A., Meier J., Sercu T. et al. Biological structure and function emerge from scaling unsupervised learning to 250 million protein sequences. Proc. Natl. Acad. Sci. USA. 2021. № 118(15). C. e2016239118.
27. Boadu R., Wang Y., Li X. Deep learning methods for protein function prediction. PROTEOMICS. 2025. № 25(1–2). C. e2300471.
28. Choi Y.H. et al. Are natural deep eutectic solvents the missing link in understanding cellular metabolism and physiology? Plant Physiol. 2011. № 156(4). C. 1701–1705.
29. Zhang T. et al. Effects of pH and molecular weight on emulsifying and foaming properties of collagen peptides from fish skin. J. Food Sci. Technol. 2024. № 61(4). C. 712–721.
30. León-López A. et al. Hydrolyzed collagen – sources and applications. Molecules. 2019. № 24(22). C. 4031.
31. Chen X. et al. Surface activity and emulsifying properties of low molecular weight collagen peptides from marine fish skin. Food Chem. 2023. № 410. C. 135412.
32. Wang Y. et al. Effect of pH on the Structure, Functional Properties and Rheological Properties of Collagen from Greenfin Horse-Faced Filefish (Thamnaconus septentrionalis) Skin. Foods. 2024. № 13(3). C. 456.
33. Santana L.B. et al. Emulsifying properties of collagen fibers: Effect of pH, protein concentration and homogenization pressure. Food Hydrocoll. 2011. № 25(4). C. 791–799.
34. Nikoo M. et al. Collagen and gelatin: Structure, properties, and applications in food industry. Int. J. Biol. Macromol. 2024. № 269. C. 131950.
35. Bai C. et al. Selective extraction of collagen peptides with high purity from cod skins by deep eutectic solvents. ACS Sustain. Chem. Eng. 2017. № 5(6). C. 5476–5484.
36. Tan Y.T. et al. Deep eutectic solvent as an innovative solvent for collagen extraction from marine by-products. J. Food Process. Preserv. 2023. № 47(10). C. e17123.
37. Heliyon Editorial Board. Deep eutectic solvents: Preparation, properties, and food applications. Heliyon. 2024. № 10(7). C. e04815

References

1. Francisco M., van den Bruinhorst A., Kroon M.C. New natural and renewable low transition temperature mixtures (LTTMs): screening as solvents for lignocellulosic biomass processing. *Green Chem.* 2012; 14(8): 2153-2157. https://doi.org/10.1039/c2gc35028d
2. Abbott A.P., Capper G., Davies D.L., Rasheed R.K., Tambyrajah V. Novel solvent properties of choline chloride/urea mixtures. *Chem. Commun.* 2003; 1: 70-71. https://doi.org/10.1039/b210714g
3. Karimi A. et al. Extraction of canola protein via natural deep eutectic solvents compared to alkaline treatments: Isolate characteristics and protein structural and functional properties. *Food Hydrocoll.* 2024; 152: 109922. https://doi.org/10.1016/j.foodhyd.2024.109922
4. Du L. et al. Extraction of protein from sesame meal: Impact of deep eutectic solvents on protein structure and functionality. *LWT* 2023; 187: 115345. https://doi.org/10.1016/j.lwt.2023.115345
5. Bai C., Wei Q., Ren X. Selective extraction of collagen peptides with high purity from cod skins by deep eutectic solvents. *ACS Sustain. Chem. Eng.* 2017; 5(6): 5476-5484. https://doi.org/10.1021/acssuschemeng.7b00316
6. Tan Y.T. et al. Deep eutectic solvent as an innovative solvent for collagen extraction from marine by-products. *J. Food Process. Preserv.* 2023; 47(10): e17123. https://doi.org/10.1111/jfpp.17123
7. Bhowmik P. et al. Impact of a Novel Two-Phase Natural Deep Eutectic Solvent-Assisted Extraction on the Structural, Functional, and Flavor Properties of Hemp Protein Isolates. *Plants* 2025; 14(2): 274. https://doi.org/10.3390/plants14020274
8. Kudłak B. et al. Application of deep eutectic solvents in protein extraction and purification. *Front. Chem.* 2022; 10: 912411. https://doi.org/10.3389/fchem.2022.912411
9. Abdipour M., Younessi-Hmazekhanlu M., Ramazani S.H.R., Omidi A. Artificial neural networks and multiple linear regression as potential methods for modeling seed yield of safflower (Carthamus tinctorius L.). *Ind. Crops Prod.* 2019; 127: 185-194. https://doi.org/10.1016/j.indcrop.2018.10.050

10. Niazian M., Sadat-Noori S.A., Abdipour M. Modeling the seed yield of Ajowan (Trachyspermum ammi L.) using artificial neural network and multiple linear regression models. *Ind. Crops Prod.* 2018; 117: 224-234. https://doi.org/10.1016/j.indcrop.2018.03.024
11. Chang C.C., Song J., Tey B.T., Ramanan R.N. Bioinformatics approaches for improved recombinant protein production in *Escherichia coli*: Protein solubility prediction. *Brief. Bioinform.* 2014; 15(6): 1047-1059. https://doi.org/10.1093/bib/bbt076
12. Rawi R., O'Connell J., Mall R. et al. DeepSol: a deep learning framework for sequence-based protein solubility prediction. *Bioinformatics* 2018; 34(15): 2605-2613. https://doi.org/10.1093/bioinformatics/bty166
13. Zhou P. Protein engineering in the deep learning era. *mLife* 2024; 3(4): 308-325. https://doi.org/10.1016/j.mlife.2024.03.004
14. Wang Y., Zhang L., Li J. et al. Modeling and optimization of collagen hydrolysis process using multilayer perceptron. *LWT* 2023; 175: 114489. https://doi.org/10.1016/j.lwt.2023.114489
15. Chen X., Zhou Y., Wang J. et al. Deep learning prediction of collagen peptide solubility using physicochemical descriptors. *J. Food Eng.* 2024; 345: 111423. https://doi.org/10.1016/j.jfoodeng.2023.111423
16. Lundberg S.M., Lee S.-I. A unified approach to interpreting model predictions. *Proc. Adv. Neural Inf. Process. Syst.* 2017; 30: 4765-4774. https://proceedings.neurips.cc/paper/2017/hash/8a20a8621978632d76c43dfd28b67767-Abstract.html
17. Rawi R., Mall R., Kloczkowski A. et al. Deeper profiles and cascaded recurrent and convolutional neural networks for state-of-the-art protein secondary structure prediction. *Sci. Rep.* 2019; 9: 12374. https://doi.org/10.1038/s41598-019-48786-3
18. Wang H., Li Y., Zhang Z. Structure-aware protein solubility prediction from sequence through graph convolutional network and predicted contact map. *Bioinformatics* 2021; 37(5): 640-647. https://doi.org/10.1093/bioinformatics/btaa720
19. Pappu S.M.J., Gummadi S.N. Artificial neural network and regression coupled genetic algorithm to optimize parameters for enhanced xylitol production by *Debaryomyces nepalensis* in bioreactor. *Biochem. Eng. J.* 2017; 120: 136–145. https://doi.org/10.1016/j.bej.2017.04.013
20. Goodfellow I., Pouget-Abadie J., Mirza M. et al. Generative adversarial nets. *Proc. Adv. Neural Inf. Process. Syst.* 2014; 27: 2672-2680. https://proceedings.neurips.cc/paper/2014/hash/5ca3e9b122f61f8f06494c97b1afccf3-Abstract.html
21. Alanazi W., Meng D., Pollastri G. DeepPredict: a state-of-the-art web server for protein secondary structure and relative solvent accessibility prediction. *Front. Bioinform.* 2025; 5: 1607402. https://doi.org/10.3389/fbioe.2025.1607402
22. Scarselli F., Gori M., Tsoi A.C. et al. The graph neural network model. *IEEE Trans. Neural Netw.* 2009; 20(1): 61-80. https://doi.org/10.1109/TNN.2008.2005605
23. Lee S., Lee M., Gyak K.-W. et al. Novel solubility prediction models: molecular fingerprints and physicochemical features vs graph convolutional neural networks. *ACS Omega* 2022; 7(14): 12268-12277. https://doi.org/10.1021/acsomega.2c01039
24. Ahmad W., Tayara H., Shim H.J., Chong K.T. SolPredictor: predicting solubility with residual gated graph neural network. *Int. J. Mol. Sci.* 2024; 25(2): 715. https://doi.org/10.3390/ijms25020715
25. Tan Y.T., Khoo C.H., Chong K.L. et al. Graph neural networks for biodiesel yield prediction in lignocellulosic biorefineries. *Renew. Energy* 2025; 215: 119012. https://doi.org/10.1016/j.renene.2024.119012
26. Rives A., Meier J., Sercu T. et al. Biological structure and function emerge from scaling unsupervised learning to 250 million protein sequences. *Proc. Natl. Acad. Sci. USA* 2021; 118(15): e2016239118. https://doi.org/10.1073/pnas.2016239118
27. Boadu R., Wang Y., Li X. Deep learning methods for protein function prediction. *PROTEOMICS* 2025; 25(1-2): e2300471. https://doi.org/10.1002/pmic.202300471
28. Choi Y.H. et al. Are natural deep eutectic solvents the missing link in understanding cellular metabolism and physiology? *Plant Physiol.* 2011; 156(4): 1701-1705. https://doi.org/10.1104/pp.111.179448
29. Zhang T. et al. Effects of pH and molecular weight on emulsifying and foaming properties of collagen peptides from fish skin. *J. Food Sci. Technol.* 2024; 61(4): 712-721. https://doi.org/10.1007/s13197-023-06648-9

30. León-López A. et al. Hydrolyzed collagen – sources and applications. *Molecules* 2019; 24(22): 4031. https://doi.org/10.3390/molecules24224031
31. Chen X. et al. Surface activity and emulsifying properties of low molecular weight collagen peptides from marine fish skin. *Food Chem.* 2023; 410: 135412. https://doi.org/10.1016/j.foodchem.2022.135412
32. Wang Y. et al. Effect of pH on the Structure, Functional Properties and Rheological Properties of Collagen from Greenfin Horse-Faced Filefish (*Thamnaconus septentrionalis*) Skin. *Foods* 2024; 13(3): 456. https://doi.org/10.3390/foods13030456
33. Santana L.B. et al. Emulsifying properties of collagen fibers: Effect of pH, protein concentration and homogenization pressure. *Food Hydrocoll.* 2011; 25(4): 791-799. https://doi.org/10.1016/j.foodhyd.2010.09.007
34. Nikoo M. et al. Collagen and gelatin: Structure, properties, and applications in food industry. *Int. J. Biol. Macromol.* 2024; 269: 131950. https://doi.org/10.1016/j.ijbiomac.2024.131950
35. Bai C. et al. Selective extraction of collagen peptides with high purity from cod skins by deep eutectic solvents. *ACS Sustain. Chem. Eng.* 2017; 5(6): 5476-5484. https://doi.org/10.1021/acssuschemeng.7b00316
36. Tan Y.T. et al. Deep eutectic solvent as an innovative solvent for collagen extraction from marine by-products. *J. Food Process. Preserv.* 2023; 47(10): e17123. https://doi.org/10.1111/jfpp.17123
37. Heliyon Editorial Board. Deep eutectic solvents: Preparation, properties, and food applications. *Heliyon* 2024; 10(7): e04815. https://doi.org/10.1016/j.heliyon.2024.e04815

Информация об авторах

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Влияние концентрата сывороточного белка на качественные характеристики и выход творога

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Аннотация. ***Введение.*** Недостаток белка в рационе человека является проблемой, с которой сталкивается население многих стан мира. Эффективным решением является использование белковых добавок, в том числе концентрата сывороточных белков (КСБ), в производстве молочных продуктов, таких как кисломолочные напитки, мороженое, творог и творожные изделия. В работе исследовали влияние КСБ на качественные характеристики нежирного творога и творога с массовой долей жира 5%. ***Материалы и методы.*** Были апробированы дозы внесения КСБ в молочные смеси 0,5, 1, 1,5, 2, 2,5 и 3%. ***Результаты и обсуждение.*** Изучены термостабильность молочных смесей для творога с КСБ при тепловой обработке и влияние концентрата сывороточного белка на кислотообразующую способность закваски на основе мезофильных лактококков (Lac. lactis) при сквашивании молока. Проведена оценка выхода готового продукта и определены органолептические, физико-химические и реологические показатели образцов творога с КСБ. ***Заключение.*** Исследования позволили отобрать образец творога с массовой долей жира 5% с дозой внесения КСБ-УФ 1 % и образец нежирного творога с дозой внесения КСБ-УФ 0,5% и сделать вывод о возможности использования творога, обогащенного концентратом сывороточного белка для изготовления творожных изделий с мягкой, пластичной, мажущейся консистенцией.

Ключевые слова: концентрат сывороточного белка, ультрафильтрация, сквашивание, синерезис, творог.

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Research article

Effect of whey protein concentrate on the quality characteristics and yield of cottage cheese

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Abstract. ***Introduction.*** The lack of protein in the human diet is a problem faced by the population of many countries around the world. An effective solution is the use of protein supplements, including whey protein concentrate (WPC), in the production of dairy products such as fermented milk drinks, ice cream, cottage cheese, and cottage cheese products. This study investigated the effect of WPC on the quality characteristics of low-fat cottage cheese and 5% fat cottage cheese. ***Materials and methods***. The doses of KSB added to milk mixtures were 0.5, 1, 1.5, 2, 2.5, and 3%. ***Results and discussion***. The thermostability of milk mixtures for cottage cheese with KSB during heat treatment and the effect of whey protein concentrate on the acid-forming capacity of a starter based on mesophilic lactococci (Lac. lactis) during milk fermentation were studied. The yield of the finished product was evaluated, and the organoleptic, physical-chemical, and rheological properties of the cottage cheese samples with KSB were determined. ***Conclusion.*** The research allowed for the selection of a 5% fat-content cottage cheese sample with a 1% dosage of ultrafiltered whey protein concentrate (UF-WPC) and a sample of low-fat cottage cheese with a 0.5% dosage of UF-WPC. It was concluded that cottage cheese enriched with whey protein concentrate can be used to produce curd products with a soft, plastic, and spreadable consistency..
Key words: whey protein concentrate, ultrafiltration, fermentation, syneresis, cottage chees
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Введение. В последние годы в пищевой промышленности наблюдается повышенный интерес к различным пищевым добавкам, среди которых особое место занимают белковые препараты. Это обусловлено глобальной проблемой дефицита пищевого белка в рационе многих людей, особенно в развивающихся странах и среди групп с ограниченным доступом к полноценному питанию. Согласно данным научных обзоров [1], нехватка белка может привести к снижению мышечной массы, ослаблению иммунитета и другим проблемам здоровья, что делает актуальным поиск способов обогащения повседневных продуктов. Одним из эффективных подходов является добавление сывороточных белков в часто потребляемые изделия, такие как кисломолочные напитки, йогурты и творожные продукты, что позволяет повысить их питательную ценность, придать им определенные качественные характеристики без значительного изменения вкуса.

Аминокислотный профиль сывороточных белков наиболее близок к составу мышечной ткани человека, что делает их идеальным источником для поддержки мышечного синтеза и восстановления. Исследования показывают, что сывороточный белок содержит около 43% незаменимых аминокислот, что выше, чем у большинства

белков растительного происхождения и даже некоторых животных [2].

Помимо питательной ценности, сывороточные белки обладают множеством биологически активных свойств, подтвержденных клиническими исследованиями. Они стимулируют иммунную систему за счет повышения уровня антиоксидантов и пребиотических эффектов, способствуя росту полезных бактерий в кишечнике, таких как *Bifidobacterium* и *Lactobacillus*, что улучшает микробиоту ЖКТ и снижает окислительный стресс. Кроме того, потребление сывороточных белков в спортивном питании повышает концентрацию инсулиноподобного фактора роста, способствуя мышечному росту и восстановлению после нагрузок, а также снижает уровень холестерина. Мета-анализ рандомизированных контролируемых испытаний показал уменьшение LDL-холестерина **(липопротеины низкой плотности)** на 5,38 мг/дл и общего холестерина на 8,58 мг/дл, особенно при сочетании с физическими упражнениями и у лиц с избыточным весом [3]. Дополнительные преимущества включают улучшение настроения за счет повышения серотонина, поддержку костной плотности у пожилых людей и потенциальную защиту печени при неалкогольной стеатогепатите [4].

В промышленном производстве для извлечения сывороточных белков применяются два основных метода: кислотно-тепловой коагуляции и мембранные технологии. Кислотно-тепловой подход включает денатурацию белков путем нагрева сыворотки до 90-95°C с добавлением кислоты для корректировки pH, затем следует центрифугирование для получения концентрата с 8-10% белка и его высушиванием до 95% сухих веществ. Однако из-за высокой стоимости, потенциального ухудшения функциональных свойств (например, снижения растворимости) этот метод используется редко. В отличие от него, мембранные методы, такие как ультрафильтрация (УФ) и микрофильтрация (МФ), получили широкое распространение благодаря экономичности и сохранению нативных свойств белков [5]. Ультрафильтрация позволяет концентрировать сыворотку до 35-80% белка в сухом веществе, а с диафильтрацией – получать изоляты с более 90% белка, без значительной денатурации, что улучшает термостабильность и снижает коагуляцию при нагеве [6].

Полученные концентраты сывороточных белков (КСБ) демонстрируют отличную растворимость в воде в диапазоне pH от 2 до 10, что делает их универсальными для продуктов с разной кислотностью. Их функциональные свойства включают высокую способность к водопоглощению (до 5-7 г воды на 1 г белка), эмульгированию, повышению вязкости, желированию при нагреве, а также стабилизацию пен и эмульсий. Эти характеристики зависят от факторов, таких как источник сыворотки, условия термообработки и хранения: например, текстурированные КСБ при 90°C показывают повышенную термостабильность и лучшую эмульсионную устойчивость по сравнению с необработанными. Такие свойства позволяют оптимизировать текстуру и сроки хранения продуктов, минимизируя синерезис и улучшая органолептические показатели.

Одним из наиболее перспективных направлений применения КСБ является производство нежирных и маложирных творожных изделий, обогащенных сывороточными белками, что способствует улучшению пищевой обеспеченности населения высококачественными продуктами. Добавление КСБ-УФ позволяет снизить жирность до минимума, сохраняя кремовую текстуру и вкус, благодаря способности белков связывать воду и формировать гели. Исследования демонстрируют [7, 8], что введение сывороточных концентратов в творог или аналогичные продукты позволяет повысить содержание белка до 13-15 г на порцию, снижает синерезис сыворотки при хранении. В обезжиренных и маложирных продуктах КСБ компенсирует потерю текстуры, делая продукт более привлекательным для потребителей с фокусом на здоровое питание.

Материалы и методы. Для выработки нежирного творога и творога с массовой долей жира 5% использовались сухие закваски прямого внесения: Choozit MA 4001 (MA 4002) LYO 25 DCU (заквасочные культуры: *Streptococcus thermophilus, Lactococcus lactis, Lactococcus cremoris, Lactococcus diacetylactis),* изготовитель: Danisco France SASLb; Choozit MM 101 LYO 25 DCU (заквасочные культуры: *Lactococcus lactis, Lactococcus cremoris, Lactococcus diacetylactis),* изготовитель: Danisco France SAS; молоко коровье цельное по ГОСТ Р 52054 – 2003; молоко коровье обезжиренное по ГОСТ 31658-2012; концентрат сывороточных белков (КСБ-УФ), полученный методом ультрафильтрации WPC 80 Milkiland, изготовитель Ostrovia Poland.

В ходе экспериментов были использованы следующие методы исследований:

- Определение титруемой кислотности по ГОСТ 3624-92;
- Определение активной кислотности по ГОСТ 26781-85;
- Определение массовой доли жира, сухих веществ, белка в молоке с помощью анализатора «Лактан 1-4М» (ООО ВПК «СибагроПРИБОР»)
- Определение массовой доли жира по ГОСТ 5867-90;
- Определение температуры по ГОСТ 26754-85 [90];
- Определение продолжительности процесса по ГОСТ 23350-98;
- Определение влаги и сухого вещества по ГОСТ 3626-73;
- Определение массовой доли белка по ГОСТ Р 53951-2010;
- Определение органолептических показателей (вкуса, запаха, цвета, консистенции) по ГОСТ 28283-89;
- Расчет массовой доли выхода продукта;
- Определение эффективной вязкости с помощью ротационного вискозиметра Реотест-2.

Целью исследований являлось изучение влияния концентрата сывороточного белка на качественные характеристики нежирного и полужирного творога.

3. Результаты исследований и обсуждения. Термическая обработка играет ключевую роль в технологии производства молочных продуктов, обеспечивая не только микробиологическую безопасность за счет уничтожения патогенных микроорганизмов, но и целенаправленное модифицирование физико-химических характеристик сырья, таких как вязкость, растворимость белков и стабильность эмульсий. В контексте изготовления кисломолочной продукции, включая творог, выбор режимов пастеризации молока напрямую влияет на динамику формирования сгустка, его склонность к синерезису и структурно-механические параметры. Температура пастеризации усиливает денатурацию сывороточных белков, способствуя их интеграции в казеиновую матрицу.

В рамках проведенного исследования особое внимание уделялось анализу воздействия различных доз КСБ-УФ на термическую устойчивость молочных смесей при рекомендуемой температуре пастеризации, применяемой в производстве творога, где оптимальные условия включают, нагрев до 78-80°С для минимизации потерь при сохранении гигиенических норм. Для эксперимента подготовили образцы молочных смесей массой 3 кг с содержанием жира 0,05% и 0,78%, обогащенные КСБ-УФ в концентрациях от 0,5% до 3% с интервалом 0,5%, в то время как контрольные образцы не содержали добавки. Перед термической обработкой в каждом варианте оценивали ключевые физико-химические показатели с использованием анализатора молока типа «Лактан 1-4М», включая кислотность, содержание белка и сухих веществ, результаты которых представлены в соответствующих таблицах 1 и 2. Все пробы подвергали пастеризации при 78±2°С с выдержкой 30 секунд – режим, гарантирующий санитарно-гигиеническую безопасность и формирующий желаемые органолептические качества, такие как кремовая текстура и мягкий вкус, без чрезмерной денатурации белков.

Таблица 1. Физико-химические показатели образцов молочной смеси с массовой долей жира 0,78%/ Table 1. Physical and chemical properties of milk mixture samples with a fat content of 0.78%

Наименование показателя	Наименование образца						
	Доза внесения КСБ, %						
	0,5	1,0	1,5	2,0	2,5	3,0	контроль
Кислотность, °Т	18	19	19	20	21	22	18
pH	6,66	6,62	6,58	6,56	6,54	6,53	6,64
Массовая доля жира, %	0,78	0,78	0,78	0,78	0,78	0,78	0,78
Массовая доля белка, %	3,45	3,48	3,51	3,54	3,78	4,1	3,4
СОМО, %	9,25	9,54	9,6	9,81	10,12	10,3	9,17

Таблица 2. Физико-химические показатели образцов молочной смеси с массовой долей жира 0,05%/ Table 2. Physical and chemical properties of milk mixture samples with a fat content of 0.05%

Наименование показателя	Наименование образца						
	Доза внесения КСБ, %						
	0,5	1,0	1,5	2,0	2,5	3,0	контроль
Кислотность, °Т	18	18	20	20	21	21	18
pH	6,66	6,64	6,62	6,55	6,53	6,52	6,68
Массовая доля жира, %	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Массовая доля белка, %	3,54	3,68	3,71	3,89	3,97	4,1	3,43
СОМО, %	9,56	9,92	10,19	10,47	10,71	10,98	9,19

Наблюдалось последовательное возрастание кислотности, доли белка и сухих веществ по мере увеличения концентрации КСБ-УФ, что согласуется с данными о том, что добавление сывороточных концентратов повышает буферную емкость системы, стабилизируя pH и предотвращая преждевременную коагуляцию при умеренных температурах.

Однако при уровнях КСБ-УФ от 2% до 3% смеси демонстрировали снижение термостабильности, приводящее к свертыванию во время нагрева с образованием кремового сгустка. Образцы с концентрациями до 1,5% сохраняли стабильность под действием тепла, не проявляя видимых изменений, что позволило отобрать для последующих этапов дозы 0,5%, 1% и 1,5% как оптимальные для баланса между обогащением и технологической устойчивостью.

Далее оценивали влияние внесенного КСБ-УФ на кислотообразующую активность заквасочной микрофлоры в процессе изготовления творога методом кислотной коагуляции, где добавка сывороточных белков может модулировать ферментационные кинетики за счет повышения содержания азота и пребиотических компонентов. Подготовленные молочные смеси с жирностью 0,05% и 0,78%, обогащенные КСБ-УФ в указанных дозах, а также контрольные без добавки, пастеризовали при 78±2°C на 30 секунд, охлаждали до 28-30°C и заквашивали классической закваской на основе мезофильных лактококков (Lactococcus lactis) в объеме 5% от массы. Смеси термостатировали при оптимальной температуре сквашивания, мониторя титруемую кислотность ежечасно. Процесс завершался при достижении титруемой кислотности 65-70°Т для обезжиренного творога и 58-60°Т для творога жирностью 5%, что заняло 12 часов во всех случаях. Графики зависимости нарастания кислотности от продолжительности процесса сквашивания образцов молочных смесей представлены на рисунках 1 и 2.

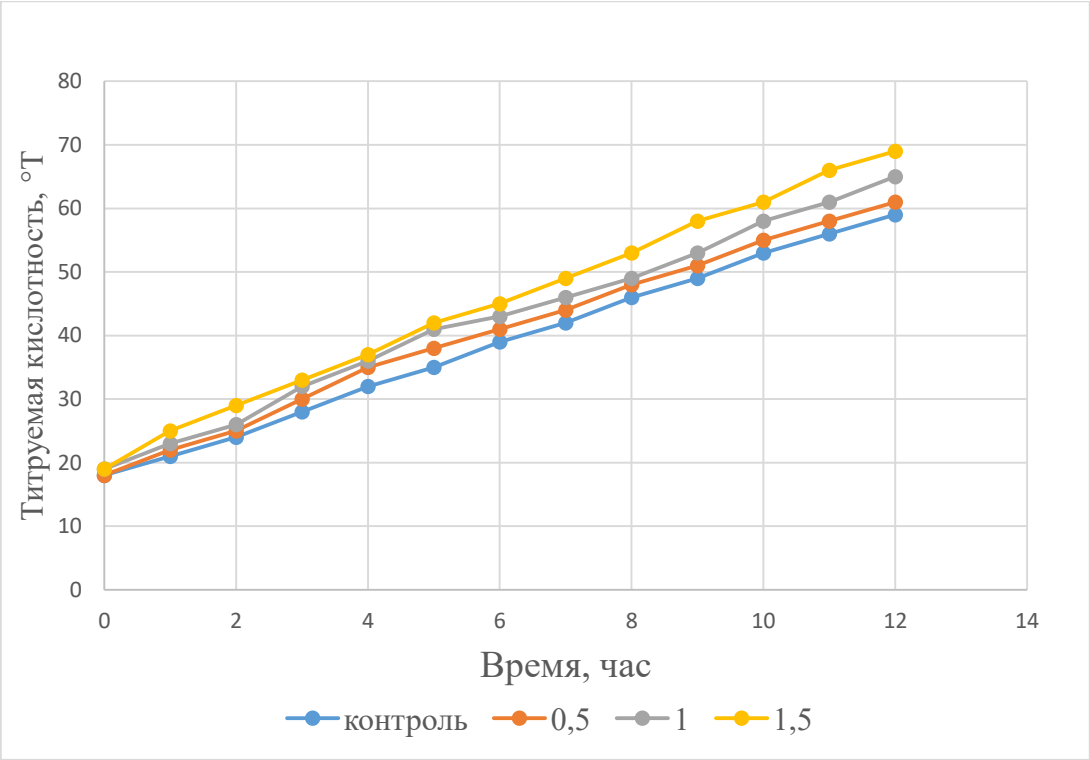

Рисунок 1 - График нарастания кислотности в серии образцов, молока с массовой долей жира 0,78%, обогащенного КСБ-УФ/ Figure 1 - Graph of acidity increase in a series of samples of milk with a mass fraction of fat of 0.78%, enriched with KSB-UV

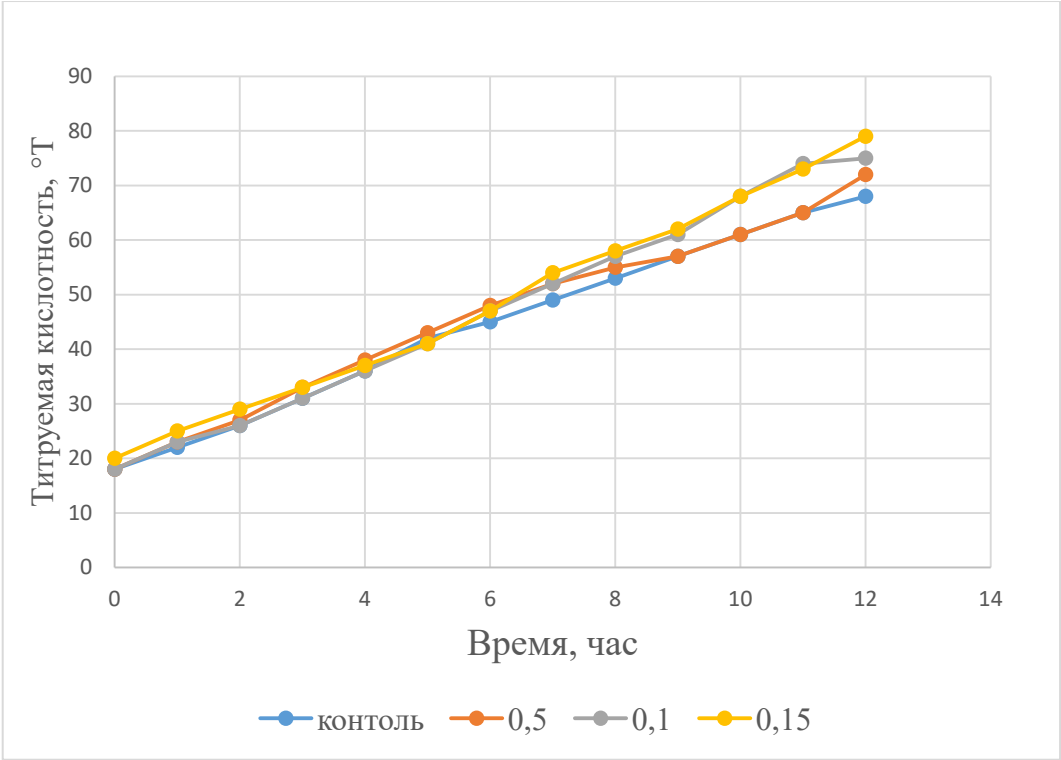

Рисунок 2 - График нарастания кислотности в серии образцов, молока с массовой долей жира 0,05%, обогащенного КСБ-УФ/ Figure 2 - Graph of acidity increase in a series of samples of milk with a mass fraction of fat of 0.05%, enriched with KSB-UV

После окончания процесса сквашивания в образцах двух серий и контрольных образцах была измерена активная кислотность продукта (таблица 3).

Таблица 3. Показатели активной кислотности творожного сгустка образцов, обогащенных КСБ-УФ после сквашивания/ Table 3. Active acidity of curd clot of samples enriched with KSB-UV after fermentation

Показатель	Массовая доля жира молочной смеси, %	Титруемая кислотность, °Т			
		контроль	доза внесения КСБ, %		
			0,5	1,0	1,5
pH	0,78	5,36	5,28	5,22	5,06
	0,05	5,29	5,13	5,10	4,94

В обогащенных пробах нарастание кислотности протекало немного интенсивнее, чем в контроле, благодаря увеличению сухих веществ, буферной емкости по щелочи и общего азота от КСБ-УФ [9]. Однако можно сделать вывод, что значительного влияния на процесс развития микрофлоры творожной закваски концентрат сывороточных белков не оказывает.

Из подготовленных сквашенных образцов был выработан творог. Выход готового продукта отражён в таблице 4.

Таблица 4. Выход творога, обогащенного КСБ-УФ/ Table 4. Yield of cottage cheese enriched with KSB-UV

Массовая доля жира молочной смеси, %	Доза внесения КСБ, %	Масса молочной смеси, кг	Масса продукта, кг	Массовая доля выхода, %
0,78	контроль	3,02	0,56	18,54
0,78	0,5	3,15	0,61	19,37
0,78	1,0	3,01	0,59	19,60
0,78	1,5	3,04	0,58	19,08
0,05	контроль	3,08	0,53	17,21
0,05	0,5	3,03	0,54	17,82
0,05	1,0	3,08	0,54	17,53
0,05	1,5	3,16	0,55	17,41

Анализ показал, что для образцов творога с жирностью 5% добавки КСБ-УФ в 1% и 1,5% не обеспечивали ожидаемого прироста выхода, в то время как максимальный выход фиксировался при дозе внесения 0,5%. КСБ повышает выход за счет лучшего удержания влаги и белка, но избыток может снижать необходимое соотношение жир:белок в нормализованных смесях для белково-жировых продуктов. Для обезжиренного творога самый большой выход достигался при 1% КСБ-УФ, что подчеркивает дозозависимый эффект добавки на конечные показатели, включая структуру, вязкость и стабильность во время хранения, с улучшением водоудерживающей способности и снижением синерезиса.

В целом, внесение КСБ-УФ оптимизирует технологические параметры, но требует точного контроля доз для предотвращения нежелательной коагуляции и максимизации выхода, что согласуется с данными исследований о взаимосвязи концентрации белка и выхода, где повышение белка усиливает скорость образования геля и снижает синерезис [10].

После получения опытных образцов творога обогащенных концентратом сывороточных белков в них были определены стандартные показатели качества для творога. Значение физико-химических показателей и вязкости исследуемых образцов представлены в таблице 5.

Таблица 5. Значение физико-химических и реологических показателей образцов творога с КСБ-УФ/ Table 5. Values of physical, chemical, and rheological parameters of cottage cheese samples with KSB-UV

Наименование показателя	Наименование образца							
	Творог нежирный				Творог с м.д.ж. 5%			
	доза внесения КСБ, %			контроль	доза внесения КСБ, %			контроль
	0,5	1,0	1,5		0,5	1,0	1,5	
Кислотность,°Т	101	108	113	95	96	99	108	94
pH	5,21	5,08	5,01	5,29	5,25	5,23	5,08	5,28
Массовая доля белка, %	18,7	19,4	19,7	18,0	16,8	17,3	17,5	16,0
Массовая доля влаги, %	71,84	74,52	82,1	70,15	73,80	74,84	79,25	68,42
Массовая доля сухих веществ, %	28,16	25,48	25,36	29,85	26,20	30,54	20,75	31,58
Вязкость, Па·с	19,09	18,63	17,18	19,52	19,23	18,96	17,34	19,89

Титруемая кислотность творога растет с увеличением дозы КСБ-УФ, что подтверждается обратной зависимостью значения pH. Предположение, что при внесении КСБ доля белка в продукте будет увеличиваться подтверждается экспериментальными данными. Массовая доля влаги в твороге увеличивается вместе с количеством внесенного КСБ, что обуславливается высокой водопоглащающей и влагоудерживающей способностью сывороточных белков, из-за образования прочных комплексов с казеином при нагревании. Отмечено, что образцы с КСБ-УФ обладают меньшей эффективной вязкостью, что благотворно влияет на консистенцию творога, придавая ему мягкость и нежность. Однако, в образцах с дозой внесения КСБ 1,5 % консистенция становилась излишне мажущей.

В ходе исследований были определены органолептические показатели образцов творога с КСБ-УФ. Для оценки органолептических показателей использовали следующие характеристики продукта: консистенция, внешний вид, вкус, запах, цвет. Оценку проводила дегустационная комиссия. Перед выдачей, пробы были закодированы цифрами от 1 до 8. Оценка органолептических показателей проводилась по 10-ти бальной шкале (1 – очень плохо, 10 – очень хорошо). Максимальную сумму баллов, набрали образцы нежирного творога с дозой внесения КСБ-УФ 0,5% и творога с массовой долей жира 5% с дозой внесения КСБ-УФ 1%. Были рассчитаны суммарные значения показателей каждого из образцов.

По данным расчёта были построены органолептические профили образцов нежирного творога, и творога с массовой долей жира 5% с КСБ-УФ и без него, которые представлены на рисунках 3 и 4.

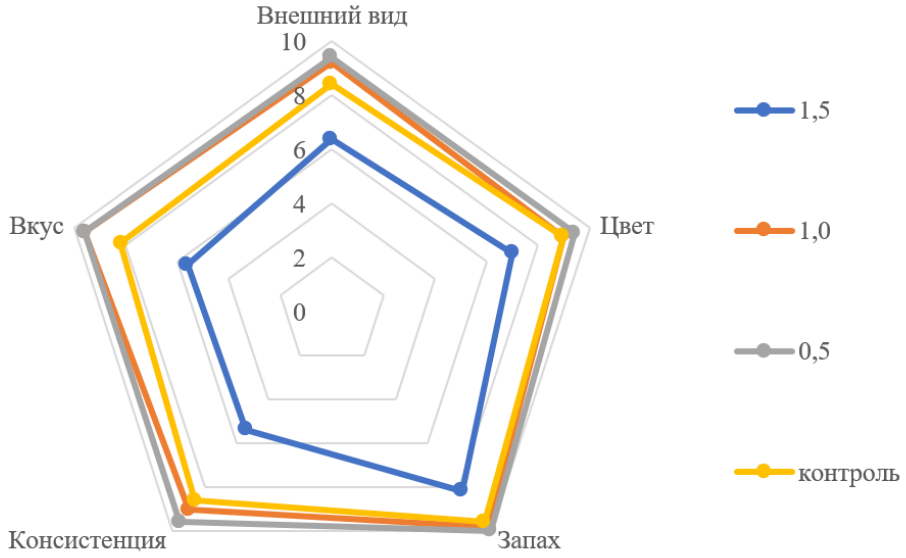

Рисунок 3 - Органолептический профиль образцов нежирного творога с КСБ-УФ/ Figure 3 - Organoleptic profile of low-fat cottage cheese samples with KSB-UV

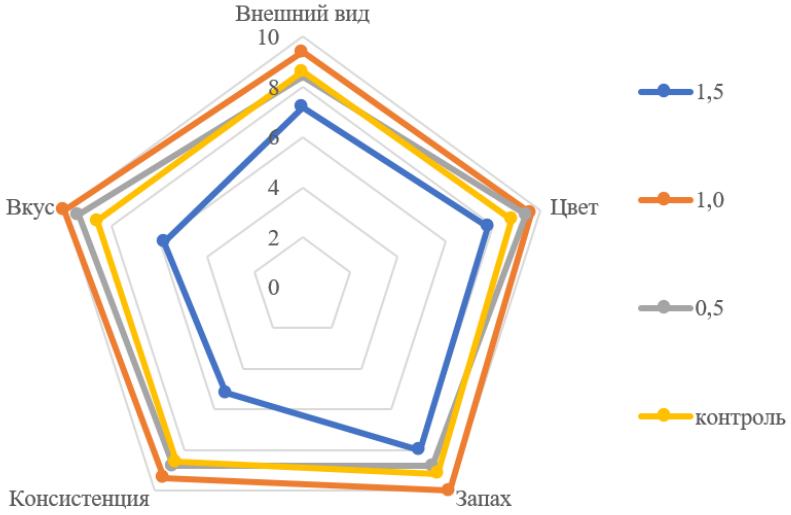

Рисунок 4 - Органолептический профиль образцов творога с массовой долей жира 5 % с КСБ-УФ/ Figure 4 - Organoleptic profile of 5% fat cottage cheese samples with KSB-UV

В ходе анализа органолептических профилей установлено, что образцы нежирного творога с дозой КСБ-УФ 1 и 1,5% и творога с массовой долей жира 5% с дозой КСБ-УФ 1,5% характеризовались крупитчатая структурой, в них наблюдались частицы нерастворившегося КСБ в виде кремовых вкраплений, а так же консистенция продукта была излишне мажущая. Другие образцы практически не отличались от контрольных образцов и соответствовали требованиям нормативно-технической документации на творог.

Заключение. Основываясь на результатах исследований процесса сквашивания образцов, изучения физико-химических, реологических и органолептических показателей, а также расчету массовой доли выхода продукта установили, что наилучшими показателями обладали: образец творога с массовой долей жира 5% с дозой внесения КСБ-УФ 1 % и образец нежирного творога с дозой внесения КСБ-УФ 0,5%.

Использование КСБ в технологии творога позволяет получить реологические и структурно-механические характеристики продукта, которые обуславливают целесообразность его применения в рецептурах творожных изделий с мягкой, мажущейся

консистенцией, обладающих повышенной пищевой и биологической ценностью. Значительным положительным эффектом является то, что концентрат сывороточного белка придает нежирным видам творога нерезинистую, пластичную структуру, что наиболее характерно для творога с массовой долей жира 9% и выше. Так же ведение КСБ в технологию получения творога позволяет регулировать влагоудержание и повышать выход готового продукта без ухудшения органолептических свойств.

Список источников

1. Cava E, Padua E, Campaci D, Bernardi M, Muthanna FMS, Caprio M, Lombardo M. Investigating the Health Implications of Whey Protein Consumption: A Narrative Review of Risks, Adverse Effects, and Associated Health Issues. Healthcare (Basel). 2024 Jan 18;12(2):246. doi: 10.3390/healthcare12020246. PMID: 38255133; PMCID: PMC10815430.
2. Gorissen SHM, Crombag JJR, Senden JMG, Waterval WAH, Bierau J, Verdijk LB, van Loon LJC. Protein content and amino acid composition of commercially available plant-based protein isolates. Amino Acids. 2018 Dec;50(12):1685-1695. doi: 10.1007/s00726-018-2640-5. Epub 2018 Aug 30. PMID: 30167963; PMCID: PMC6245118.
3. The effects of whey protein supplementation on indices of cardiometabolic health: A systematic review and meta-analysis of randomized controlled trials/ K. Prokopidis, P.T. Morgan, N. Veronese, J. Morwani-Mangnani , K. K. Triantafyllidis, K. S. Kechagias, J. Roberts , C.Hurst , E. Stevensonj, D. Vlachopoulos, O. C. Witard. Clinical Nutrition Volume 44, January 2025, Pages 109-121 https://doi.org/10.1016/j.clnu.2024.12.003.
4. J. Zhang, X. Tong, Z. Wan, Y. Wang, L. Qin, I. Szeto/ Effect of whey protein on blood lipid profiles: a meta-analysis of randomized controlled trialsnEur J Clin Nutr, 70 (2016), pp. 879-885; M. Vajdi, V. Musazadeh, M. Zareei, S. Adeli, A. Karimi, A. Hojjati, et al.The effects of Whey protein on blood pressure: a systematic review and dose-response meta-analysis of randomized controlled trials Nutr Metab Cardiovasc Dis, 33 (9) (2023), pp. 1633-1646; K. Wirunsawanya, S. Upala, V. Jaruvongvanich, A. Sanguankeo. Whey protein supplementation improves body composition and cardiovascular risk factors in overweight and obese patients: a systematic review and meta-analysis. J Am Coll Nutr, 37 (2018), pp. 60-70.
5. Комплексный подход к производству белковых ингредиентов на основе молочного сырья / Д. Н. Володин, В. К. Топалов, И. А. Евдокимов [и др.] // Молочная промышленность. 2022. № 1. С. 34-36.
6. Новое поколение белковых ингредиентов на основе фракционирования молока / Д. Н. Володин, В. К. Топалов, И. К. Куликова, И. А. Евдокимов // Переработка молока. 2021. № 8(262). С. 10-12.
7. Morr, C. V., Ha, E. (2017). «Whey proteins and their applications in food products» Food Technology, 71(6), 30-39.
8. Pérez, M., Martínez, L. (2022). «The role of whey proteins in reducing syneresis in low-fat yogurts», Journal of Food Science, 87(1), 45-52. DOI: 10.1111/1750-3841.16400.
9. Формирование белковых структур молочных систем с концентратом мицеллярного казеина в технологии греческого йогурта / М. В. Каледина, В. П. Витковская, М. И. Шрамко [и др.] // Индустрия питания. 2025. Т. 10, № 2. С. 57-66.
10. Giroux, Hélène & Dupont, Florence & Villeneuve, Geneviève & Britten, Michel. (2020). Effect of heating milk on whey protein denaturation and cheese-making properties. International Dairy Journal. 111. 104831. 10.1016/j.idairyj.2020.104831.

References

1. Cava E, Padua E, Campaci D, Bernardi M, Muthanna FMS, Caprio M, Lombardo M. Investigating the Health Implications of Whey Protein Consumption: A Narrative Review of Risks, Adverse Effects, and Associated Health Issues. Healthcare (Basel). 2024 Jan 18;12(2):246. doi: 10.3390/healthcare12020246. PMID: 38255133; PMCID: PMC10815430.
2. Gorissen SHM, Crombag JJR, Senden JMG, Waterval WAH, Bierau J, Verdijk LB, van Loon LJC. Protein content and amino acid composition of commercially available plant-based protein isolates. Amino Acids. 2018 Dec;50(12):1685-1695. doi: 10.1007/s00726-018-2640-5. Epub 2018 Aug 30. PMID: 30167963; PMCID: PMC6245118.

3. The effects of whey protein supplementation on indices of cardiometabolic health: A systematic review and meta-analysis of randomized controlled trials/ K. Prokopidis, P.T. Morgan, N. Veronese, J. Morwani-Mangnani, K. K. Triantafyllidis, K. S. Kechagias, J. Roberts , C.Hurst , E. Stevensonj, D. Vlachopoulos, O. C. Witard// Clinical Nutrition Volume 44, January 2025, Pages 109-121 https://doi.org/10.1016/j.clnu.2024.12.003.
4. J. Zhang, X. Tong, Z. Wan, Y. Wang, L. Qin, I. Szeto/ Effect of whey protein on blood lipid profiles: a meta-analysis of randomized controlled trialsnEur J Clin Nutr, 70 (2016), pp. 879-885; M. Vajdi, V. Musazadeh, M. Zareei, S. Adeli, A. Karimi, A. Hojjati, et al.The effects of Whey protein on blood pressure: a systematic review and dose-response meta-analysis of randomized controlled trials Nutr Metab Cardiovasc Dis, 33 (9) (2023), pp. 1633-1646; K. Wirunsawanya, S. Upala, V. Jaruvongvanich, A. Sanguankeo. Whey protein supplementation improves body composition and cardiovascular risk factors in overweight and obese patients: a systematic review and meta-analysis. J Am Coll Nutr, 37 (2018), pp. 60-70.
5. Kompleksnyi podkhod k proizvodstvu belkovykh ingredientov na osnove molochnogo syr'ya / D. N. Volodin, V. K. Topalov, I. A. Evdokimov [i dr.]. Molochnaya promyshlennost'. 2022. № 1. S. 34-36.
6. Novoe pokolenie belkovykh ingredientov na osnove fraktsionirovaniya moloka / D. N. Volodin, V. K. Topalov, I. K. Kulikova, I. A. Evdokimov. Pererabotka moloka. 2021. № 8(262). S. 10-12.
7. Morr, C. V., Ha, E. (2017). «Whey proteins and their applications in food products» Food Technology, 71(6), 30-39.
8. Pérez, M., Martínez, L. (2022). «The role of whey proteins in reducing syneresis in low-fat yogurts», Journal of Food Science, 87(1), 45-52. DOI: 10.1111/1750-3841.16400.
9. Formirovanie belkovykh struktur molochnykh sistem s kontsentratom mitsellyarnogo kazeina v tekhnologii grecheskogo iogurta / M. V. Kaledina, V. P. Vitkovskaya, M. I. Shramko [i dr.]. Industriya pitaniya. 2025. T. 10, № 2. S. 57-66.
10. Giroux, Hélène & Dupont, Florence & Villeneuve, Geneviève & Britten, Michel. (2020). Effect of heating milk on whey protein denaturation and cheese-making properties. International Dairy Journal. 111. 104831. 10.1016/j.idairyj.2020.104831.

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Разработка показателей качества сырья «Череды поникшей трава»

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Аннотация. ***Введение.*** Череда поникшая (Bidens cernua L.) является перспективным производящим лекарственным растением, содержащим флавоноиды и полиацетилены, однако оно недостаточно изучено и не имеет установленных фармакопейных стандартов качества на получаемое из него лекарственное растительное сырьё. ***Цель.*** Разработка комплекса нормируемых показателей качества для «Череды поникшей травы», включая макро- и микроскопические признаки, числовые нормативы и методы хроматографической идентификации, для её стандартизации и потенциального использования в фармацевтике и производстве БАД. ***Материалы и методы.*** Исследование проводили на образцах надземной части череды поникшей, собранных в Московской области и Ставропольском крае. Применяли стандартные фармакопейные методики (ГФ РФ XIV изд.) для определения морфологических, микроскопических признаков и числовых показателей (влажность, зольность, примеси, экстрактивные вещества). Для качественного анализа полиацетиленов и флавоноидов использовали тонкослойную хроматографию (ТСХ). ***Результаты и обсуждение.*** Установлены диагностические макро- и микроскопические признаки сырья. На основе экспериментальных данных предложены следующие нормы: влажность – не более 12%; общая зола – не более 7%; зола, нерастворимая в 10% HCl – не более 2%; органическая примесь – не более 2%; минеральная примесь – не более 1%; экстрактивные вещества (70% этанол) – не менее 30%. Разработаны и валидированы методики ТСХ-идентификации полиацетиленов и флавоноидов для подтверждения подлинности сырья. ***Заключение.*** Разработанный комплекс показателей качества позволяет стандартизировать сырьё «Череды поникшей трава». Полученные результаты обосновывают его перспективность для создания БАД с антиоксидантной, капилляроукрепляющей, противовоспалительной и дерматотропной активностью.

Ключевые слова: череда поникшая, полиацетиленовые соединения, флавоноиды, показатели подлинности и качества

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Research article

Development of quality indicators for the raw material "Bidentis cenuae herba"

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Abstract. ***Introduction.*** Bidens cernua L. is a promising medicinal plant producing flavonoids and polyacetylenes; however, it has been insufficiently studied and has no established pharmacopoeial quality standards for the medicinal plant materials obtained from it. ***Goal.*** To develop a set of standardized quality indicators for "Bidentis cernuae herba", including macro- and microscopic characteristics, numerical standards, and chromatographic identification methods, for its standardization and potential use in pharmaceuticals and dietary supplement production. ***Materials and Methods.*** The study was conducted on samples of the aerial parts of Bidens cernua collected in the Moscow Region and Stavropol Krai. Standard pharmacopoeial methods (State Pharmacopoeia of the Russian Federation, 14th edition) were used to determine morphological, microscopic characteristics, and numerical indicators (moisture, ash content, impurities, extractives). Thin-layer chromatography (TLC) was used for the qualitative analysis of polyacetylenes and flavonoids. ***Results and discussion.*** Diagnostic macro- and microscopic properties of the raw material were established. Based on the experimental data, the following standards were proposed: moisture – no more than 12%; total ash – no more than 7%; ash insoluble in 10% HCl – no more than 2%; organic impurity – no more than 2%; mineral impurity – no more than 1%; extractive substances (70% ethanol) – no less than 30%. TLC identification methods for polyacetylenes and flavonoids were developed and validated to confirm the authenticity of the raw material. ***Conclusion.*** The developed set of quality indicators allows standardizing the raw material of "Bidentis cernuae herba". The obtained results substantiate its potential for the creation of a dietary supplement with antioxidant, capillary-strengthening, anti-inflammatory and dermatotropic activity

Key words: Bidens cernua, polyacetylene compounds, flavonoids, indicators of authenticity and quality
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Introduction. Bidens cernua L. is a promising type of medicinal plant material containing a complex of biologically active compounds, in particular flavonoids and polyacetylenes, which determine its pharmacological activity [1-4]. Unlike Bidens tripartita L., the raw material of Bidens cernua has been studied to a much lesser extent and does not have established pharmacopoeial quality standards. The development of a set of indicators, including macro- and microscopic characteristics, as well as numerical indicators (moisture, ash content, impurity and extractive substance content), is a necessary step for the standardization of this type of raw material and ensuring its proper quality. Chromatographic determination of key groups of biologically active compounds serves as an important tool for identifying the raw material and confirming its authenticity. The present work is aimed at a comprehensive study and establishment of standardized characteristics for Bidens cernua L. herb, which will facilitate its

possible introduction into the composition of dietary supplements, in medical practice and pharmaceutical production.

Materials and methods of research. The object of the study were samples of the above-ground part of Bidens, drooping (upper 15-20 cm), collected during the flowering phase in the Moscow region and Stavropol territory. After collection, the samples were air-dried at a temperature not exceeding 35-40 °C. They were stored in paper bags in accordance with the requirements of OFS.1.1.0011.15 of the State Pharmacopoeia of the Russian Federation, XIV edition [5]. The study of external, microscopic features, quality indicators and the establishment of their standards for the studied raw materials were carried out using standard pharmacopoeial methods. For chromatographic analysis, Sorbfil PTSKh-P-A plates (10x15 and 10x10 cm) were used, activated for 60 minutes in a drying oven (100-105 ºC). Solutions of individual compounds, extracts and their fractions were applied by a standard method using a microsyringe.

Research results and discussion. As a result of the study, external characteristics were established for whole and crushed raw materials. “Whole raw materials consist of whole or partially crushed leafy shoots, their individual fragments (stems, leaves, flower baskets, unripe fruits). The leaves are simple, opposite, without a petiole, lanceolate up to 12 cm long. The apex is pointed, the margin is serrate-dentate. Flower baskets are 1.0–1.5 cm in diameter, collected in inflorescences on elongated stalks; bisexual, tubular. Involucral leaflets are linear-oblong, with spiny cilia along the margin. Achenes are inversely cuneate , with two (rarely 3-4) awns, half the length of the achene. The leaves are green or brownish-green, the stems are green, and the flowers are yellow or golden-yellow. The smell is faint and characteristic, and the taste is bitter.

"The crushed raw material (no more than 7 mm) is a mixture of fragments of flowers, buds, achenes, leaves, and stems, containing pieces of leaves, ribbed stems, flower heads, buds, and achenes of the corresponding color. The odor is faint, the taste is bitter."

Microscopic analysis revealed the following diagnostically significant structures:

– on the surface of the leaf blade, on both sides, anomocytic stomata and thin-walled hairs are found, consisting of 5-10 cells and resembling a caterpillar in shape;

– in the mesophyll of the leaf, especially along the veins and along its edge, numerous secretory passages of various shapes and thick-walled hairs formed by 4-6 cells are localized;

- on the surface of the epidermis of the outer and inner leaflets of the wrapper, cells with sinuous walls were found on both sides, as well as two types of hairs: caterpillar-like (of 6-10 cells) and thick-walled (of 4-6 cells);

– when examining the petals of the corolla of tubular flowers under a microscope, especially at their base, secretory passages, caterpillar-like hairs and pollen grains with a spiny surface are observed.

Determination of quality indicators and standards. Moisture determination. The moisture content of the raw materials was determined in accordance with the methodology of the State Pharmacopoeia of the Russian Federation, 14th edition [5]. The results are presented in Table 1.

Table 1 – Results of determining the moisture content of the Chamaenerion angustifolium herb a

Collection region raw materials	f	Humidity value, % (x)	$\bar{x}$	S	t_P(f)	Δx, %	E, %
Stavropol Krai	5	11.05; 11.44; 11.25; 10.17; 10.96; 11.12	11:00	0.4390	2.57	0.4606	4.19
Moscow region	5	11.19; 10.82; 10.76; 10.35; 11.48; 10.61	10.87	0.4067	2.57	0.4267	3.93

Experimental data demonstrate that the moisture content of raw materials from the Stavropol Krai ranges from 10.17% to 11.44%, with an average of 11.00%. Samples from the Moscow Region ranged from 10.35% to 11.48%, with an average of 10.87%. Based on these results and statistical analysis (confidence level P = 0.95), the moisture content standard for raw materials was set at no more than 12%.

Determination of total ash and ash insoluble in a 10% hydrochloric acid solution. Ash analysis was conducted in accordance with the requirements of the State Pharmacopoeia of the Russian Federation, 14th edition [5]. The results are presented in Tables 2 and 3.

Table 2 – Total ash content in the Chamaenerion angustifolium raw material

Region of raw material collection	f	Total ash, % (x)	$\bar{x}$	S	t_P (f)	Δx, %	E, %
Stavropol Krai	5	5.76; 6.13; 5.92; 5.64; 6.32; 5.85	5.94	0.2495	2.57	0.2618	4.41
Moscow region	5	5.84; 6.43; 6.31; 5.96; 6.04; 6.17	6.13	0.2213	2.57	0.2322	3.79

Table 3 – Content of ash insoluble in 10% HCl in the raw material of Stachys laxa

Region of raw material collection	f	Ash insoluble in 10% hydrochloric acid solution, % (x)	$\bar{x}$	S	t_P (f)	Δx, %	E, %
Stavropol Krai	5	1.39; 1.43; 1.52; 1.44; 1.48; 1.41	1.45	0.0476	2.57	0.0500	3.46
Moscow region	5	1.58; 1.64; 1.53; 1.66; 1.57; 1.52	1.58	0.0568	2.57	0.0596	3.76

Experimental data showed that the total ash content in the raw materials ranged from 5.64% to 6.43%, while the content of ash insoluble in a 10% hydrochloric acid solution ranged from 1.39% to 1.66%. Based on these data, and taking into account pharmacopoeial requirements for similar types of medicinal plant materials, the following standards were established: the total ash content should not exceed 7%, and the content of ash insoluble in a 10% hydrochloric acid solution should not exceed 2%.

Determination of impurity content, degree of grinding, and extractive substances. The impurity content (organic and mineral), the degree of grinding of raw materials, and the content of extractive substances extracted with 70% ethyl alcohol were assessed in accordance with the instructions of the State Pharmacopoeia of the Russian Federation, 14th edition [5,6,7]. The results are presented in Table 4.

Table 4 – Indicators of impurity content, degree of fragmentation, and extractive substances in the raw material of «Chereda drooping herb"

Indicator (x), %	Growing region	
	Stavropol Krai	Moscow region
Organic impurity, no more than	1.54 ± 0.06	1.41 ± 0.07
Mineral impurity, no more than	0.69 ± 0.02	0.53 ± 0.03
Extractive substances extracted with 70% ethyl alcohol	38.56 ± 1.74	32.87 ± 1.40
Whole raw material. Particles passing through a 3 mm sieve.	3.51 ± 0.16	3.18 ± 0.17
Crushed raw materials. Particles that do not pass through a 7 mm sieve.	4.17 ± 0.19	3.46 ± 0.16
Crushed raw material. Particles passing through a sieve with 0.18 mm holes	3.68 ± 0.17	3.55 ± 0.19

According to the table data, the content of organic impurities in the raw materials ranged on average from 1.41% to 1.54%, mineral impurities – from 0.53% to 0.69%. The content of extractive substances extracted by 70% ethyl alcohol varied within the range from 32.87% to 38.56%. Analysis of the degree of grinding showed that for whole raw materials, the proportion of particles passing through a sieve with 3 mm holes did not exceed 3.51%, and for crushed raw materials, the proportion of particles not passing through a 7 mm sieve was up to 4.17%, and the proportion of particles passing through a 0.18 mm sieve was up to 3.68%.

Based on these results and generally accepted pharmacopoeial norms, the following quality standards were established:

– organic impurity content – no more than 2%.

– mineral impurity content – no more than 1%.

– the content of extractive substances extracted with 70% ethyl alcohol is not less than 30%.

– for whole raw materials: particles passing through a sieve with 3 mm holes – no more than 5%.

– for crushed raw materials: particles that do not pass through a sieve with 7 mm holes – no more than 5%; particles that pass through a sieve with 0.18 mm holes – no more than 5%.

Development of methods for the qualitative determination of the main groups of biologically active compounds

Chromatographic determination of polyacetylene compounds. Thin-layer chromatography was used to determine polyacetylenes. The following method was developed as a result of the research: "1 µl of a hexane solution of essential oil extracted from Bidens sylvatica herb and a hexane solution of a standard phenylheptatriene sample are applied to the starting point of a chromatographic plate. After removing the solvent, the plate is placed in a chromatographic chamber pre-saturated with mobile phase vapor (hexane). Chromatography is carried out in an ascending manner until the solvent front has traveled approximately 90% of the plate length. Once complete, the plate is removed and dried."

For visualization, the dried plate is uniformly sprayed with a vanillin solution in concentrated sulfuric acid and heated at 100–105°C. This should result in the formation of at least two distinct adsorption zones. Identification of the polyacetylene compound zones is based on two criteria: when irradiated with UV light at 365 nm, the zone exhibits bright yellow fluorescence and has an Rf value in the range of 0.5–0.55.

Chromatographic determination of flavonoid compounds. Preparation of solutions. Rutin solution : approximately 0.005 g of rutin (rutin trihydrate) is dissolved in 10 ml of 95% ethyl alcohol. Shelf life: no more than 3 months.

Quercetin SO solution: approximately 0.005 g of quercetin dihydrate or anhydrous quercetin is dissolved in 10 ml of 95% ethyl alcohol. Shelf life is no more than 3 months.

1% diphenylboryloxyethylamine solution in 95% alcohol: dissolve 1.0 g of reagent in 100 ml of 95% ethyl alcohol. Shelf life: no more than 3 months.

5% polyethylene glycol (PEG) solution in 95% alcohol: 5.0 ml of PEG 400 is mixed with 100 ml of 95% ethyl alcohol. Shelf life: up to 6 months.

Sample preparation and chromatography. Approximately 1.0 g of crushed raw material (particles pass through a 0.5 mm sieve) is placed in a flask, 10 ml of 95% ethyl alcohol is added, a reflux condenser is attached, and the mixture is heated in a water bath for 10 minutes. The cooled extract is filtered. The resulting filtrate is the test solution.

A 30 µl sample of the test solution is applied to the starting line of a silica gel chromatography plate as a strip (10 x 3 mm). 5 µl of each rutin and quercetin RS solutions are applied simultaneously. The plate is air-dried.

The plate is placed in a chamber pre-saturated with mobile phase vapor (ethyl acetate – anhydrous formic acid – water, 40:4:6) for at least 30 minutes. Chromatography is performed in an ascending fashion until the front has traveled 80–90% of the plate's length. The plate is removed and dried.

Identification and evaluation of results. The dried plate is heated for 2-3 minutes at 100–105°C. The warm plate is sequentially treated with a 1% solution of diphenylboryloxyethylamine and a 5% solution of PEG, then kept at room temperature for 30 minutes.

When viewed in daylight, the chromatogram of the sample should show two zones: the rutin zone (yellow, yellow-orange, or orange) and the quercetin zone located above (yellow, yellow-orange, or orange). The chromatogram of the test solution should show a distinct yellow zone located above the obligatory red or violet-red zone.

To confirm the results, the chromatogram is viewed under UV light at a wavelength of 365 nm.

Conclusion. The comprehensive research conducted allowed us to develop a quality indicator system for the medicinal plant material "Sequina drooping grass." During the study, diagnostically significant external and microscopic features were identified, enabling reliable identification of the raw material. Clear descriptions of the morphological characteristics were proposed for both whole and crushed raw materials.

Based on experimental data obtained for samples from various growing regions and taking into account the requirements of the State Pharmacopoeia of the Russian Federation, the following standardized numerical indicators were established:

- humidity – no more than 12%;
- total ash – no more than 7%;
- ash insoluble in 10% hydrochloric acid solution – no more than 2%;
- organic impurities – no more than 2%;
- mineral impurities – no more than 1%;
- extractive substances extracted with 70% ethyl alcohol – not less than 30%;
- degree of grinding: for whole raw materials – particles passing through a sieve with 3 mm holes, no more than 5%; for crushed raw materials – particles not passing through a 7 mm sieve, and particles passing through a 0.18 mm sieve, no more than 5%.

Methods for the qualitative chromatographic (TLC) determination of polyacetylene and flavonoid compounds, which are necessary for confirming the authenticity of raw materials, have been developed and tested.

The data obtained opens up prospects for the development of various biologically active supplements (BAS) based on the raw material "Bed-Quill Grass." Due to its flavonoid and polyacetylene compounds, the raw material can serve as the basis for the development of:

- Dietary supplement with antioxidant and capillary-strengthening activity;
- means that promote the normalization of metabolic processes;
- anti-inflammatory and dermatotropic complex drugs.

Список источников

1. Коновалов, Д.А., Насухова А.М. Полиацетиленовые соединения у видов рода Bidens. Фармация и фармакология. 2014. Т.2, №2(3). С. 34–65. https://doi.org/10.1007/s11094-014-1159-7.
2. Коновалов, Д.А. Ароматические полиацетиленовые соединения семейства Asteraceae и их хемотаксономическое значение. Раст. ресурсы. 1996. Т.32, № 4. С. 84-98.
3. Насухова, А.М., Коновалов Д.А. Сравнительное изучение эфирного маслаи гексанового извлечения из надземной части Bidens cernua L. Вестн. Волгоград. гос. мед. уни-та. 2015. №1(53). С. 50–52.
4. Корожан, Н. В. Изменчивость содержания флавоноидов и полисахаридов в траве череды поникшей. Химия растительного сырья. 2020. №3. С. 197-206. https://doi.org/10.14258/jcprm.2020035357.
5. Государственная фармакопея Российской Федерации. Available from: http://femb.ru/femb/pharmacopea.php (дата обращения: 14.09.2025).
6. Коновалов, Д.А. Полиацетиленовые соединения у видов рода Bidens / Д.А. Коновалов, А.М. Насухова. Фармация и фармакология. 2014. Т.2, №2(3). С. 34-65.

7. Насухова А. М., Коновалов Д. А. Биологически активные соединения череды поникшей травы // Современная наука и инновации. 2025. №3. С. 100-115 https://doi.org/10.37493/2307-910X.2025.3.10

References

1. Konovalov, D.A., Nasukhova A.M. Poliatsetilenovye soedineniya u vidov roda Bidens. Farmatsiya i farmakologiya. 2014. T.2, №2 (3). S. 34–65. https://doi.org/10.1007/s11094-014-1159-7.
2. Konovalov, D.A. Aromaticheskie poliatsetilenovye soedineniya semeistva Asteraceae i ikh khemotaksonomicheskoe znachenie. Rast. resursy. 1996. T.32, № 4. S. 84-98.
3. Nasukhova, A.M., Konovalov D.A. Sravnitel'noe izuchenie ehfirnogo maslai geksanovogo izvlecheniya iz nadzemnoi chasti Bidens cernua L. Vestn. Volgograd. gos. med. uni-ta. 2015. №1 (53). S. 50–52.
4. Korozhan, N. V. Izmenchivost' soderzhaniya flavonoidov i polisakharidov v trave cheredy ponikshei. Khimiya rastitel'nogo syr'ya. 2020. №3. S. 197-206. https://doi.org/10.14258/jcprm.2020035357.
5. Gosudarstvennaya farmakopeya Rossiiskoi Federatsii. Available from: http://femb.ru/femb/pharmacopea.php (data obrashcheniya: 14.09.2025).
6. Konovalov, D.A. Polyacetylene compounds in Bidens species. D.A. Konovalov, A.M. Nasukhova. Pharmacy and Pharmacology. 2014. Vol. 2, No. 2(3). Pp. 34-65.
7. Nasukhova A. M., Konovalov D. A. Biologically Active Compounds of the Drooping Meadowgrass. Modern Science and Innovations. 2025. No. 3. Pp. 100-115 https://doi.org/10.37493/2307-910X.2025.3.10

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Сбор данных, проведение экспериментальных исследований. Подготовка и редактирование текста – составление черновика рукописи.

Дмитрий Алексеевич Коновалов

Проведение исследования – интерпретация и анализ полученных данных. Утверждение окончательного варианта – принятие ответственности за все аспекты работы, целостность всех частей статьи и её окончательный вариант.

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Contribution of the authors:

Aida M. Nasukhova

Collected data from published sources, carrying out experimental research. Prepared and edited the text – drafted the manuscript.

Dmitry A. Konovalov

Conducted the study – interpreted and analyzed the data.Approved the final version – accepts responsibility for all aspects of the work, the integrity of all parts of the article, and its final version.

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Изучение процессов получения микрокапсулированных экстрактов растений для применения в косметических средствах и продуктах функционального питания

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Аннотация. ***Введение*** Лекарственные растения играют важную роль в медицине, особенно в традиционных системах, где растительные экстракты составляют треть всех средств, особенно для лечения кожных заболеваний. В последние десятилетия возрос интерес к их биоактивным компонентам, таким как флавоноиды и терпеноиды, благодаря их антиоксидантным, противовоспалительным и иммунорегуляторным свойствам. Эти экстракты эффективны в борьбе с возрастными изменениями кожи, улучшении её внешнего вида и функций. Они используются в безрецептурных препаратах, БАДах и пищевых продуктах для профилактики хронических заболеваний. Современные исследования подтверждают их эффективность в лечении дерматологических заболеваний. Экстракты алоэ, ромашки и календулы применяются в косметических средствах, а куркумы и зелёного чая — в пищевой промышленности как антиоксидантные добавки. Растительные экстракты представляют перспективное направление. Благодаря их биоактивным свойствам и многовековому опыту применения, играют ключевую роль в создании инновационных продуктов для улучшения здоровья и качества жизни. ***Материалы и методы.*** Целью настоящего исследования является комплексное изучение влияния гидромодуля (соотношение "сырье (г): экстрагент (мл)") на физико-химические характеристики экстрактов биологически активных соединений (БАС), полученных из различных растительных источников, а также оптимизация параметров микрокапсулирования альгината натрия. В рамках исследования были выбраны следующие объекты: Цветки календулы лекарственной (Calendula officinalis L.),Листья шалфея лекарственного (Salvia officinalis L.),Трава тысячелистника обыкновенного (Achillea millefolium L.),Надземная часть каллизии душистой (Callisia fragrans). Параметры экстракции были стандартизированы следующим образом: температура 50 °C, гидромодули 1:5, 1:10 и 1:15, метод мацерации продолжительностью 2 часа с использованием дистиллированной воды. Для микрокапсулирования применялись альгинат натрия и хлорид кальция. ***Результаты и обсуждение.*** Получены уравнения для определения значений установившихся амплитуд колебаний. Исследовано влияние дисперсии, вызванной несовпадением температур и скоростей фаз газовзвеси, на нелинейное взаимодействие стоячих волн. ***Заключение.*** Исследования показали, что микрокапсулированные экстракты календулы и шалфея перспективны для косметики и функциональных продуктов питания благодаря высокой биодоступности и стабильности активных компонентов. Микрокапсулирование улучшает физико-химические характеристики экстрактов, повышая их растворимость и дисперсность. Это улучшает потребительские свойства продуктов.

Экстракты обладают антиоксидантными, противовоспалительными и регенеративными свойствами, а также содержат биологически активные вещества, положительно влияющие на здоровье. Внедрение микрокапсулированных экстрактов открывает новые возможности для создания инновационных продуктов, соответствующих современным требованиям рынка.

Ключевые слова: календула лекарственная, шалфей лекарственный, тысячелистник обыкновенный, каллизия душистая, экстракты, альгинат натрия, микрокапсулы

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Research article

Study of plant microcapsulated extracts preparation intended for use in cosmetics and functional foods technology

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Abstract. ***Introduction.*** Introduction Medicinal plants play an important role in medicine, especially in traditional systems, where plant extracts account for a third of all remedies, especially for the treatment of skin diseases. In recent decades, there has been an increased interest in their bioactive components, such as flavonoids and terpenoids, due to their antioxidant, anti-inflammatory, and immunoregulatory properties. These extracts are effective in combating age-related skin changes and improving skin appearance and function. They are used in over-the-counter medications, dietary supplements, and food products for the prevention of chronic diseases. Modern research confirms their effectiveness in the treatment of dermatological diseases. Extracts of aloe, chamomile, and calendula are used in cosmetics, while extracts of turmeric and green tea are used in the food industry as antioxidant additives.. ***Materials and methods.*** Materials and methods. The aim of the present study is a comprehensive study of the effect of the hydro-modulus (the ratio "raw material (g): extractant (ml)") on the physical and chemical characteristics of extracts of biologically active compounds (BAS) obtained from various plant sources, as well as the optimization of the parameters of microencapsulation of sodium alginate. The following objects were selected as part of the study: Calendula officinalis L. flowers, Salvia officinalis L. leaves, Yarrow grass (Achillea millefolium L.), and the aerial part of Callisia fragrans. The extraction parameters were standardized as follows: temperature 50 °C, hydro-moduli 1:5, 1:10 and 1:15, 2-hour maceration method using distilled water. Sodium alginate and calcium chloride were used for microencapsulation. ***Conclusion.*** Research has shown that microencapsulated extracts of calendula and sage are promising for cosmetics and functional food products due to their high bioavailability and stability of active components. Microencapsulation improves the physical and chemical characteristics of the extracts, increasing their solubility and dispersion. This enhances the consumer properties of the products. The extracts have antioxidant, anti-inflammatory, and regenerative properties, as well as contain biologically active substances that have a positive impact on health. The introduction of microencapsulated extracts opens up new opportunities for creating innovative products that meet modern market requirements.

Key words: calendula officinalis, sage officinalis, yarrow, callisia fragrans, extracts, sodium alginate, microcapsules
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Introduction

Virtually all cultures around the world have historically relied or continue to rely on medicinal plants for primary health care. Approximately one-third of all traditional medicines are intended for the treatment of wounds or skin diseases, compared to only 1-3% of modern medicines [10].

Biologically active substances (BAS) from medicinal plants has grown worldwide, as **substances** capable of positively influencing biochemical reactions in the human body. Skin aging is considered a natural physiological process, and photoaging, pigmentation, and damage to the epidermal barrier due to lipid peroxidation and other factors can be treated with cosmetics based on biologically active plant components [8].

Plant extracts and individual compounds are increasingly used in cosmetics, as well as in over-the-counter medications and dietary supplements for functional nutrition. Experimental research using plant components is a promising area for the near future. [12].

Scientific research proves the positive effect on the human body, in particular on the skin, of extracts from medicinal plants containing valuable biologically active substances with a calming, anti-inflammatory and antioxidant effect [15].

Natural plant-based skin care ingredients are being actively developed and used not only for their rejuvenating effect, but also for use on problem skin [14].

Currently, extracts from medicinal plants are effectively used as additives to food products to improve their properties and functional significance [2].

Calendula extract (Calendula officinalis) contains biologically active substances: polyphenols, p-hydroxybenzoic, salicylic, vanilla, coffee, gallic acids, acylated flavonoid-O-glycosides, methoxylated flavonoids, amino acids, alkaloids, carotenoids, saponins, tannins, high-molecular polysaccharides and triterpenoid monoesters [11]. It has been experimentally established that marigold flowers have bactericidal, anti-inflammatory, soothing and healing effects.

Sage extract (Salvia officinalis) contains coumarins, alkaloids, flavonoids, saponins, polyphenols, phenolic and flavonoid glycosides, sclareol, rosmarinic , gallic, chicory and ferulic acids, dihydroquercetin, rutin, coumarin, umbelliferone, salts of K, Ca, Fe, Mn, Zn, Li, Sn, essential oil [1, 5].

The active components of sage extract have a powerful antifungal, anti-inflammatory and soothing effect, have antioxidant properties, tighten pores, and are used in the fight against acne [16].

Yarrow extract (A. chilea millefolium) contains the alkaloid achilleine, volatile oils, sesquiterpene lactones, tannins, flavonoids, phytoncides, vitamins C and K, carotene, organic acids (isovaleric, formic, acetic), essential oil [4, 7]. It has anti-inflammatory, antioxidant, and wound-healing effects [13].

The chemical composition of *Callisia fragrans extract* is represented by different classes of compounds: carbohydrates, amino acids, organic acids, phenolic compounds, triterpene compounds and alkaloids. Palmitic, linoleic, oleic and linolenic acids, carotenoids (α-, β-

carotenes, neoxanthin, antheraxanthin), chlorophylls (a and b), ascorbic acid and anthocyanins [9], as well as salicylic, vanillic and chlorogenic acids, phytol, vanillin, biformene, squalene, lupeol and betulin [3] have been found.

Gallic, caffeic, chicory, and ferulic acids, quercetin, kaempferol, umbelliferone, scopoletin, and aloe-emodin were identified among the phenolic compounds. The data obtained indicate the presence of antioxidant activity due to the presence of phenolic compounds and ascorbic acid [6].

When used in topical products, the main challenge is instability caused by external factors (such as oxygen, temperature, and light) during transportation and storage, which affects the product's shelf life. In this regard, microencapsulation has shown great potential for increasing the stability of biologically active substances.

Materials and methods

The aim of the research was to study the influence of the hydromodulus values (the ratio of "raw material (g): extractant (ml)") on the physicochemical parameters of various extracts of biologically active substances of selected plants and to optimize the parameters of the process of obtaining sodium alginate microcapsules with plant extracts.

The following raw materials were used as research objects for the preparation of plant extracts:

- crushed calendula flowers, produced by Krasnogorskleksredstva, Krasnogorsk, Reg. No.: LP-003154;
- crushed sage leaves, produced by Krasnogorskleksredstva, Krasnogorsk, Reg. No.: LSR-005376/07;
- crushed yarrow herb, produced by Krasnogorskleksredstva, Krasnogorsk, Reg. No.: LP-004327;
- the above-ground part of fragrant callisia, produced by the experimental farm of the Saratov State Agricultural University named after N.I. Vavilov, Saratov.

For the initial stage of the research, the following extraction process parameters were selected: temperature 50°C. The water-to-water ratios were 1:5, 1:10, and 1:15. The maceration extraction procedure lasted 2 hours. Distilled water was used as the extractant.

To prepare microcapsules, food grade sodium alginate, CAS 9005-38-3, and food grade anhydrous calcium chloride, CAS 10043-52-4 were used.

Results and discussion

To study the dynamics of the extraction process, the following physicochemical parameters were used: pH of the medium, mass fraction of dry substances (%), freezing temperature (°C), optical density (D), antioxidant activity (AOA, mM trolox).

Tables 1, 2, 3 and 4 present experimental data reflecting the dynamics of changes in the physicochemical parameters of plant extracts with hydraulic module values of 1:5, 1:10 and 1:15.

Table 1. Physical and chemical properties of calendula extract at different hydromodules

No.	Hydro-module	pH of the environment	Mass fraction of dry matter, %	Freezing point, ° C	Optical density, D	AOA, Mm trolox
1	1:15	5.28	2.9	-0.407	7.35	3.87
2	1:10	5.23	4.2	-0.561	11.35	5.40
3	1:5	5.1	5.5	-1,123	15.79	11.4

Source: compiled by the authors by authors

Table 2. Physical and chemical properties of Callisia fragrans extract at different hydromodules

No.	Hydro-module	pH of the environment	Mass fraction of substances, %	Freezing point, ° C	Optical density, D	AOA, mM Trolox
1	1:15	5.83	0.1	-0.038	3.4	1.2
2	1:10	5.76	0.7	-0.058	5.9	2.6
3	1:5	5.68	0.9	-0.103	7.3	4.7

Source: compiled by the authors by authors

Table 3. Physical and chemical properties of yarrow extract at different hydromodules

No.	Hydro-module	pH of the environment	Mass fraction of substances, %	Freezing point, ° C	Optical density, D	AOA, mM Trolox
1	1:15	5.6	1.6	-0.188	4.66	5.2
2	1:10	5.55	2.25	-0.248	4.86	5.3
3	1:5	5.49	4.1	-0.475	4.89	10.6

Source: compiled by the authors by authors

Table 4. Physical and chemical properties of sage extract at different hydromodules

No.	Hydro-module	pH of the environment	Mass fraction of substances, %	Freezing point, ° C	Optical density, D	AOA, mM Trolox
1	1:15	6.39	1.9	-0.169	7.79	10.1
2	1:10	6.32	2.9	-0.241	10.55	19.1
3	1:5	6.13	4.2	-0.456	18.04	36.8

Source: compiled by the authors by authors

Based on the results of studies of the physicochemical properties of plant extracts, it can be concluded that the optimal hydromodulus in terms of the dynamics of increase in dry matter and optical density is 1:10.

A further increase in the hydromodulus did not lead to a significant increase in the mass fraction of dry substances in the extracts, optical density and antioxidant activity and increased the consumption of raw materials.

Extracts of yarrow and fragrant callisia were characterized by a reduced dry matter content, high raw material consumption and relatively low antioxidant activity values, therefore extracts of calendula and sage were selected for further research.

Encapsulation of plant extracts of calendula and sage was carried out on an experimental setup for microencapsulation of colloidal raw materials II 0.35-1.5 (OOO MZTA, Murom) at a disperser drive speed of 2000 rpm.

The morphological features and sizes of hydrated microcapsules were analyzed using an Axio ZOOM.V16 light microscope (Carl Zeiss Microscopy, Oberkochen, Germany) with a magnification of x50.

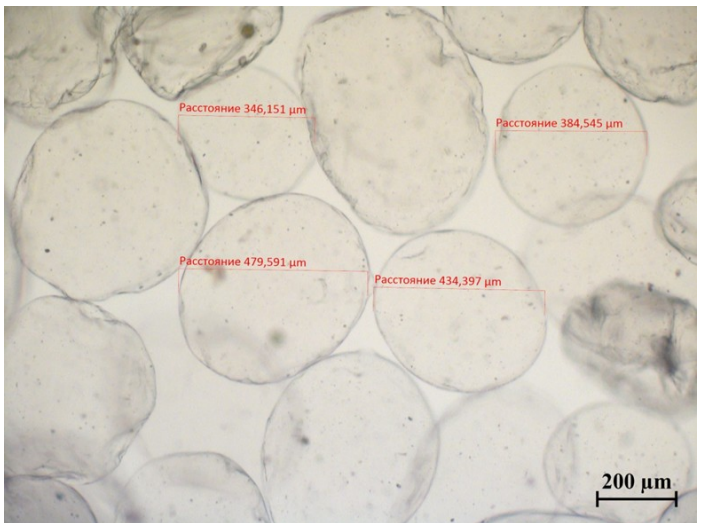

Figure 1. Appearance of sodium alginate microcapsules with calendula extract

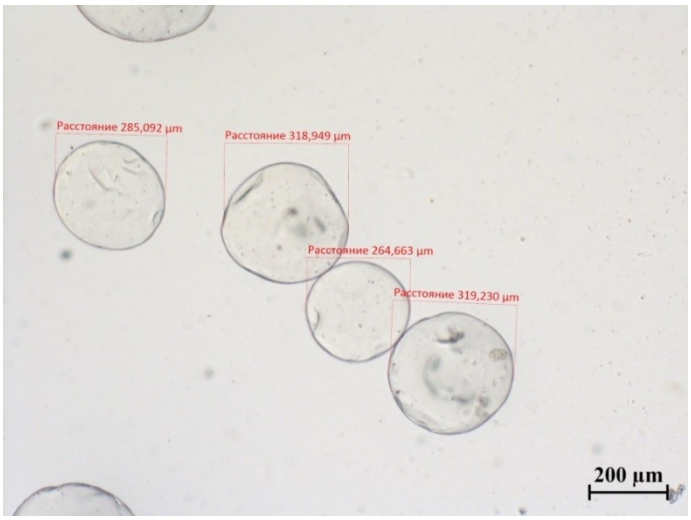

Figure 2. Appearance of sodium alginate microcapsules with sage extract

Microscopy analysis of microcapsule samples containing calendula and sage plant extracts showed an average size of 280 to 500 micrometers at an optimal sodium alginate solution flow rate of 2.5 ml/min and a CaCl2 concentration $_{in}$ the curing solution of 1.5%.

Increasing the flow rate above 2.5 ml/min resulted in increased sodium alginate consumption and deterioration of the microcapsule formation process in the microencapsulation unit.

Conclusion

According to the results of the experiments, the optimal hydraulic module is 1:10. A further increase in the content of medicinal plants in the solution did not lead to a significant increase in dry matter, optical density and antioxidant activity and increased the consumption of raw materials.

Samples of yarrow and fragrant callisia extracts were found to have low dry matter content and antioxidant activity, so it was decided not to conduct further studies with these extracts.

The parameters of microencapsulation were established with an optimal flow rate of sodium alginate solution of 2.5 ml/min and a CaCl2 concentration $_{in}$ the hardening solution of 1.5%.

The research has shown that microencapsulated extracts of calendula and sage can be used in the production of cosmetics and functional food products.

Список источников

1. Аминова, М.З. Антибактериальные и противовоспалительные свойства лекарственного растения Шалфей / М.З. Аминова, И.ДЖ. Кароматов // Электронный научный журнал «Биология и интегративная медицина». 2018. № 10. С. 41–55.
2. Ахметьянов, Р.Т. Тысячелистник обыкновенный (achillea millefolium l.) в качестве основы для продуктов функционального назначения / Р.Т. Ахметьянов, З.М. Хасанова, Л.А. Хасанова // Вестник Башкирского Государственного педагогического университета им. М. Акмуллы. 2019. №1. С. 6–11
3. Кондратьева, В.В. Callisia fragrans (Lindl.) Woodson как продуцент физиологически активных соединений / В.В. Кондратьева, Д.В. Курилов, Т.В. Воронкова [и др.] // Современная физиология растений: от молекул до экосистем: тез. докл. межд. конф. Сыктывкар. 2007. С. 366–368
4. Константинов, Ю. Ю. Тысячелистник, кипрей. Природные лекарства. / Ю. Ю. Константинов // Центрполиграф. 2014. С. 160.
5. Косман, В.М. Изучение состава биологически активных веществ сухих экстрактов эхинацеи узколистной и шалфея лекарственного / В.М. Косман, О.Н. Пожарицкая, А.Н. Шиков // Химия растительного сырья. 2012. №1. С. 153–160.
6. Оленников, Д.Н. Химический состав сока каллизии душистой (Callisia fragrans wood.) и его антиоксидантная активность (in vitro) / Д.Н. Оленников, И.Н. Зилфикаров, А.А. Торопова // Химия растительного сырья. 2008. №4. С. 95–100.
7. Раделов, С. Ю. Все о лекарственных растениях / С. Ю. Раделов // Санкт-Петербург ООО «СЗКЭО». 2016. С. 192.
8. Семенова, Е.В. Биологически активные вещества лекарственных растений, применяемые в медицине и косметологии для поддержания здоровья и красоты кожи. / Е.В. Семенова, Е.В. Почечуева//Международный студенческий научный вестник. 2025. № 2. URL: https://eduherald.ru/ru/article/view?id=21824 (дата обращения: 12.05.2025)
9. Черненко, Т.В. Химическое исследование Callisia fragrans / Т.В. Черненко, Н.Т. Ульченко, А.И. Глушенкова // Химия природных соединений. – 2007. – №3. – С. 212–213
10. Anti-Inflammatory Activity of Calendula officinalis L. Flower Extract Diva Silva. // Ferreira, M., Sousa-Lobo, J., Cruz, M. // Cosmetics. 8 (31), P. 2-7, 2021. URL: https://doi.org/10.3390/cosmetics8020031 (date of request: 05/12/2025).
11. Botanicals in dermatology: an evidence-based review // Reuter, J., Merfort, I., Schempp, CM. // Am J Clin Dermatol. 11(4), P. 247-67, 2010.
12. Evaluation of Antioxidant, Anti-inflammatory and Anti-arthritic Activities of Yarrow (Achillea millefolium) // Mohamed, D., Hanfy, E., Fouda, K. // Journal of Biological Sciences. P. 317-328, 2018.
13. Innovations in natural ingredients and their use in skin care // Fowler, JF. Jr, Woolery-Lloyd, H., Waldorf, H. // Drugs Dermatol. 9(6), P. 72-81, 2010.
14. Natural products and extracts from plants as natural UV filters for sunscreens: A review. // Li, .L, Chong, L., Huang, .T. // Animal Model Exp Med. 6(3), P.183-195, 2023.
15. Phytotherapeutic use of medicinal plant raw materials in cosmetology // Semenova, E., Abapolova, I., Belinskaya, R. // International Journal of Applied and fundamental research. № 10, P. 43-48, 2023.

References

1. Aminova, M.Z. Antibakterial'nye i protivovospalitel'nye svoistva lekarstvennogo rasteniya Shalfei / M.Z. Aminova, I.DZH. Karomatov // Ehlektronnyi nauchnyi zhurnal «Biologiya i integrativnaya meditsinA». 2018. № 10. S. 41–55.
2. Akhmet'yanov, R.T. Tysyachelistnik obyknovennyi (achillea millefolium l.) v kachestve osnovy dlya produktov funktsional'nogo naznacheniya / R.T. Akhmet'yanov, Z.M. Khasanova, L.A. Khasanova // Vestnik Bashkirskogo Gosudarstvennogo pedagogicheskogo universiteta im. M. Akmully. 2019. №1. S. 6–11

3. Kondrat'eva, V.V. Callisia fragrans (Lindl.) Woodson kak produtsent fiziologicheski aktivnykh soedinenii / V.V. Kondrat'eva, D.V. Kurilov, T.V. Voronkova [i dr.] // Sovremennaya fiziologiya rastenii: ot molekul do ehkosistem: tez. dokl. mezhd. konf. Syktyvkar. 2007. S. 366–368
4. Konstantinov, YU. YU. Tysyachelistnik, kiprei. Prirodnye lekarstva. / YU. YU. Konstantinov. Tsentrpoligraf. 2014. S. 160.
5. Kosman, V.M. Izuchenie sostava biologicheski aktivnykh veshchestv sukhikh ehkstraktov ehkhinatsei uzkolistnoi i shalfeya lekarstvennogo / V.M. Kosman, O.N. Pozharitskaya, A.N. Shikov. Khimiya rastitel'nogo syr'ya. 2012. №1. S. 153–160.
6. Olennikov, D.N. Khimicheskii sostav soka kallizii dushistoi (Sallisia fragrans wood.) i ego antioksidantnaya aktivnost' (in vitro) / D.N. Olennikov, I.N. Zilfikarov, A.A. Toropova. Khimiya rastitel'nogo syr'ya. 2008. №4. S. 95–100.
7. Radelov, S. YU. Vse o lekarstvennykh rasteniyakh / S. YU. Radelov // Sankt-Peterburg OOO «SZKEHO». 2016. S. 192.
8. Semenova, E.V. Biologicheski aktivnye veshchestva lekarstvennykh rastenii, primenyaemye v meditsine i kosmetologii dlya podderzhaniya zdorov'ya i krasoty kozhi. / E.V. Semenova, E.V. Pochechueva. Mezhdunarodnyi studencheskii nauchnyi vestnik. 2025. № 2. URL: https://eduherald.ru/ru/article/view?id=21824 (data obrashcheniya: 12.05.2025)
9. Chernenko, T.V. Khimicheskoe issledovanie Callisia fragrans / T.V. Chernenko, N.T. Ul'chenko, A.I. Glushenkova. Khimiya prirodnykh soedinenii. 2007. №3. S. 212–213
10. Anti-Inflammatory Activity of Calendula officinalis L. Flower Extract Diva Silva. // Ferreira, M., Sousa-Lobo, J., Cruz, M. Cosmetics. 8 (31), P. 2-7, 2021. URL: https://doi.org/10.3390/cosmetics8020031 (date of request: 05/12/2025).
11. Botanicals in dermatology: an evidence-based review // Reuter, J., Merfort, I., Schempp, CM. Am J Clin Dermatol. 11(4), P. 247-67, 2010.
12. Evaluation of Antioxidant, Anti-inflammatory and Anti-arthritic Activities of Yarrow (Achillea millefolium) // Mohamed, D., Hanfy, E., Fouda, K. Journal of Biological Sciences. P. 317-328, 2018.
13. Innovations in natural ingredients and their use in skin care // Fowler, JF. Jr, Woolery-Lloyd, H., Waldorf, H. Drugs Dermatol. 9(6), P. 72-81, 2010.
14. Natural products and extracts from plants as natural UV filters for sunscreens: A review. // Li, .L, Chong, L., Huang, .T. Animal Model Exp Med. 6(3), P.183-195, 2023.
15. Rhytotherapeutic use of medicinal plant raw materials in cosmetology // Semenova, E., Abapolova, I., Belinskaya, R. International Journal of Applied and fundamental research. № 10, P. 43-48, 2023.

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Преемственность культурного наследия в условиях технологической трансформации: философская рефлексия о соотношении традиций и инноваций

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Аннотация. В данной статье анализируется проблема сохранения культурного наследия в условиях стремительной технологической трансформации, которая оказывает значительное влияние на культурные ценности и практики. Автор проводит философскую рефлексию на тему соотношения традиций и инноваций, исследуя, как технологические изменения трансформируют культурное пространство и идентичность. В рамках данного исследования рассматриваются механизмы взаимодействия между инновационными процессами и традиционными культурными формами, а также их влияние на социокультурную динамику. Особое внимание уделяется вопросам преемственности и адаптации культурного наследия в условиях глобализации и цифровизации.

Ключевые слова: культурное наследие, преемственность, технологическая трансформация, традиции, инновации, философские основы, рефлексивный анализ.
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Research article

The continuity of cultural heritage in the context of technological transformation: a philosophical reflection on the relationship between tradition and innovation

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Abstract. This article analyzes the problem of preserving cultural heritage in the context of rapid technological transformation, which has a significant impact on cultural values and practices. The author conducts a philosophical reflection on the relationship between traditions and innovations, exploring how technological changes transform cultural space and identity. This study examines the mechanisms of interaction between innovative processes and traditional cultural forms, as well as their impact on sociocultural dynamics. Special attention is given to the issues of continuity and adaptation of cultural heritage in the context of globalization and digitalization...

Key words: cultural heritage, continuity, technological transformation, traditions, innovations, philosophical foundations, and reflective analysis.

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Introduction

In today's world, where globalization and technological change are accelerating the transformation of cultural and social norms, traditional values are under threat of extinction. However, despite this, they remain an important source of identity and societal resilience. Philosophers and scholars are actively discussing and rethinking these values, seeking to understand their role in shaping individual and collective consciousness.

Research methodology

Studying the ethical foundations of these values is key to understanding their significance. Traditional values not only reflect cultural characteristics but also form moral guidelines that help people make decisions and build relationships. In a context of rapid change, it is important to preserve these guidelines to ensure stability and continuity. In his work "Foundations of the Metaphysics of Morals," Immanuel Kant emphasized: "Man must act in such a way that his actions can become a universal law." [1]. According to I. Kant, a person's actions should be guided by maxims (rules) that could become universal laws. That is, each person's actions should be such that they could become the norm for everyone without contradiction. This idea implies that a moral act should not be selfish and limited by the interests of one person. It should take into account the interests and rights of others and also correspond to universal moral principles. In the modern world, this idea is more relevant than ever. We live in a time when the actions of each person can have far-reaching consequences for all of humanity. Furthermore, modern society faces numerous ethical dilemmas related to technological developments and cultural differences.

In his work "Utilitarianism," John Stuart Mill argued: "The only thing that makes a man's actions moral or immoral is their effect on the happiness of others" [2]. He substantiates the principle of utility as the primary ethical principle. "Utility is not merely the happiness of the majority, but also the harmony of the soul, where freedom from suffering becomes a bridge to the greatest enjoyment of life" [2].

Results and discussions

Thus, studying the ethical foundations of traditional values allows us to gain a deeper understanding of their role in shaping moral guidelines and their significance in the face of rapid change. Traditional values such as respect for elders, honesty, and fairness serve as the foundation for many cultures and societies, defining norms of behavior and interaction between people. These values have evolved over centuries, reflecting the accumulated experience and

wisdom of previous generations. However, in the modern world, where artificial intelligence (AI) and technological innovations are rapidly reshaping social structures and norms, traditional values may be under threat. On the one hand, AI has enormous potential to improve quality of life, automate processes, and solve complex problems. On the other hand, it also poses new ethical dilemmas related to issues of privacy, fairness, and responsibility.

Artificial intelligence can analyze large volumes of data and make decisions based on algorithms that don't always take human emotions, cultural contexts, and moral principles into account. This raises concerns that traditional values may be replaced by other approaches based on efficiency and optimization. Consequently, it becomes necessary to find answers to the following questions: How can we maintain a balance between innovation and the preservation of traditional values? How can we preserve the continuity of traditions and the uniqueness of cultural heritage in the era of artificial intelligence and innovation, which can both enrich and transform cultural values and practices?

In the philosophy of N.A. Berdyaev, we find reflections on the role of culture and traditions in the formation of the human personality and society. In his opinion, culture, as a phenomenon, has a special spiritual and sacred essence. It is not simply the totality of the material and spiritual achievements of humanity, but also the bearer of the highest values, ideals and meanings. Culture is an expression of the inner world of man, his desire for self-knowledge and spiritual perfection. In this sense, it goes beyond pragmatic goals, acquiring sacred significance, since “it was conceived around the temple and in its organic period was connected with religious life” [3, p. 411]. The connection with religion gives it special spiritual depth and significance. The basis of culture is the cult of ancestors, reverence for graves and monuments, as well as sacred traditions and legends passed down from generation to generation. These elements form a cultural heritage that connects times and preserves the memory of the past. “Culture,” writes N.A. Berdyaev, “is always proud of the antiquity of his origins, his inseparable connection with the great past.” [3, p.249].

In N.A. Berdyaev's philosophy, culture is presented as a phenomenon with a spiritual and sacred essence, a bearer of the highest values and ideals. In the age of artificial intelligence and innovation, it is important to preserve the continuity of traditions and the uniqueness of cultural heritage, lest we lose touch with our roots and devalue spiritual values.

Ancient culture, with its high value and aesthetic significance, represents a unique phenomenon, accumulating the finest achievements of a people over the centuries. Who can deny its role as a repository of spiritual wisdom, moral imperatives, and aesthetic ideals, fostering a sense of identity and connection to historical heritage? Culture thus serves as a link between the past and the future, ensuring the continuity and evolution of cultural traditions. Isn't it amazing how it connects us with our ancestors and inspires new achievements? These ideas are reflected in the works of philosophers such as Plato in The Republic [4], where he views culture as a means of cultivating virtues and shaping a harmonious personality.

Not only by enriching the lives of individuals but also by significantly influencing the development of society as a whole, culture contributes to the preservation and enhancement of cultural heritage. This process can be viewed as the systematic accumulation and transmission of cultural values, which helps preserve the uniqueness and diversity of a nation's cultural experience.

In the context of reassessing the importance of cultural heritage in shaping collective consciousness, it's worth turning to Hegel's philosophical insights, presented in his seminal work, The Phenomenology of Spirit [5]. Hegel argues that culture represents a dynamic process of a people's self-awareness, which not only reflects its historical development but also serves as a platform for philosophical understanding of reality. Cultural heritage, therefore, can be viewed as the accumulation of spiritual and material values that are formed during the historical evolution of society. It serves as a tool for a nation's self-knowledge, allowing it to understand its place in the world, its achievements and mistakes, and to develop specific worldviews and ideological guidelines.

Philosophical ideas embedded in cultural heritage play a key role in this process. They contribute to the formation of a collective consciousness, creating shared understandings of the world, humanity, and its place in the universe. These ideas not only reflect historical realities but also shape new paradigms of thought that can have a significant impact on the future development of society.

Consequently, cultural heritage is an integral part of the process of shaping collective consciousness. It serves not only as a mirror reflecting a people's historical journey but also as an active tool facilitating their further development and self-improvement.

Thus, ancient culture, as an integral part of human heritage, represents a complex system integrating historical, philosophical, and aesthetic aspects, making it an important object of study and preservation for future generations. Shouldn't we make every effort to preserve and enhance this priceless treasure for our ancestors? These thoughts find echoes in the works of Hannah Arendt in The Life of the Mind [6], where she emphasizes that culture is the foundation for human freedom and creativity, as well as in the works of Karl Jaspers in The Origins of History and Its Goals [7], where he considers culture a key element in understanding human history and identity.

Rapid technological advances, particularly in fields such as artificial intelligence, genetic modification, and biotechnology, raise complex questions about the permissibility and limits of their application [8, 98–107]. These technologies open up new horizons and opportunities, but simultaneously pose serious ethical and philosophical challenges for society. How can traditional values, such as respect for life and nature, be preserved in a context where technology can lead to unforeseen consequences?

This issue is complex and multifaceted, touching on various scientific and philosophical aspects. Firstly, it is closely intertwined with ethical and moral dilemmas, as well as with the problems of defining and redefining values. It encourages people to reflect on their actions and their impact on both their own existence and the lives of others. In this context, it becomes necessary to find a balance between personal freedom and responsibility to society, as well as between innovation and the preservation of cultural heritage. Secondly, it represents a complex task requiring a deep understanding of the processes occurring in the natural and social spheres. Scientists are faced with the need to develop and implement technologies that not only minimize negative impacts on the environment but also harmoniously integrate into existing social structures without contradicting traditional values and beliefs [9].

Although technological progress is rapidly changing many aspects of life, philosophical analysis shows that traditional values, as the foundation of national identity, continue to exert a significant influence on the perception of innovations and their integration into culture. Despite the fact that technology can transform cultural norms, many societies strive to preserve their traditional values to ensure the continuity and sustainability of their cultural and historical community.

Conclusion

In the context of global technological transformation, the phenomenon of cultural heritage continuity acquires particular significance as a fundamental principle for preserving cultural identity and ensuring intergenerational connection. A philosophical understanding of this process reveals not only the dichotomy between tradition and innovation but also their synergistic relationship, facilitating the emergence of new forms of cultural expression. On the one hand, technological innovations can lead to the loss of certain elements of cultural heritage and the transformation of value orientations, potentially threatening the integrity of cultural tradition. On the other hand, innovations act as a catalyst for the rethinking and adaptation of traditional values, creating the conditions for the emergence of new forms of cultural discourse and symbolic capital.

Thus, philosophical reflection on the interaction of tradition and innovation in the context of cultural heritage continuity focuses not only on potential challenges but also on emerging

opportunities. It emphasizes the importance of maintaining a connection to cultural roots, respecting historical heritage, and the right to creative rethinking and innovatively exploring new paths of development. This is the fundamental philosophical meaning of cultural heritage continuity in the context of technological transformation, which requires further in-depth research and understanding.

Список источников

1. Кант, Иммануил. Основы метафизики нравственности [Текст]: общественно-политическая литература / Иммануил Кант; [под общей редакцией: В. Ф. Асмуса, А. Г. Гулыги, Т. И. Ойзермана], 1999. 1470 с.
2. Милль Джон Стюарт Утилитаризм: Пер. с англ / предисл. А.С. Земерова − Ростов-на-Дону. Донской издательский дом. 2013 г., 240 с.
3. Бердяев, Н. А. Философия неравенства. М.:, 1963. 321 с.
4. Платон Сочинения в четырех томах. Т. 3 Ч. 1 / Под общ. ред. А.Ф.Лосева и В.Ф.Асмуса; Пер. с древнегреч. СПб.: Изд-во С.-Петерб. ун-та; «Изд-во Олега Абышко», 2007. 752 с.
5. Гегель Г. В. Ф. Феноменология духа / пер. с нем. Г. Шпета. Москва: Наука, 2000. 495 с. (Слово о сущем).
6. Арендт Х. Жизнь ума / Ханна Арендт; [пер. с англ. А. В. Говорунова]. Санкт-Петербург: Наука, 2013. 517, [1] с. (Слово о сущем).
7. Ясперс К. Истоки истории и её цель // Смысл и назначение истории. Москва: Политиздат, 1991. − С. 28-286. (Серия «Философы XX века»).
8. Жуковская, Н. Т. Научно-технический прогресс и ответственность государства за сохранность культурных корней // Государственная служба. 2018. № 2. С. 98-107.
9. Иванов, И. И. Традиционные ценности и технологический прогресс в современном обществе. Москва: Институт философии РАН, 2017. 256 с.

References

1. Kant, Immanuil. Osnovy metafiziki nravstvennosti [Tekst]: obshchestvenno-politicheskaya literatura / Immanuil Kant; [pod obshchei redaktsiei: V. F. Asmusa, A. G. Gulygi, T. I. Oizermana], 1999. 1470 s.
2. Mill' Dzhon Styuart Utilitarizm: Per. s angl / predisl. A.C. Zemerova Rostov-na-Donu. Donskoi izdatel'skii dom. 2013 g., 240 s.
3. Berdyaev, N. A. Filosofiya neravenstva. M.:, 1963. 321 s.
4. Platon Sochineniya v chetyrekh tomakh. T. 3 CH. 1 / Pod obshch. red. A.F.Loseva i V.F.Asmusa; Per. s drevnegrech. SPb.: Izd-vo S.-Peterb. un-ta; «Izd-vo Olega AbyshkO», 2007 752 s.
5. Gegel' G. V. F. Fenomenologiya dukha / per. s nem. G. Shpeta. Moskva: Nauka, 2000. 495 s. (Slovo o sushchem).
6. Arendt KH. Zhizn' uma. Khanna Arendt; [per. s angl. A. V. Govorunova]. Sankt-Peterburg: Nauka, 2013. 517, [1] s. (Slovo o sushchem).
7. Yaspers K. Istoki istorii i ee tsel' . Smysl i naznachenie istorii. Moskva: Politizdat, 1991. S. 28-286. (Seriya «Filosofy XX vekA»).
8. Zhukovskaya, N. T. Nauchno-tekhnicheskii progress i otvetstvennost' gosudarstva za sokhrannost' kul'turnykh kornei.Gosudarstvennaya sluzhba. 2018. № 2. S. 98-107.
9. Ivanov, I. I. Traditsionnye tsennosti i tekhnologicheskii progress v sovremennom obshchestve. − Moskva: Institut filosofii RAN, 2017. − 256 s.

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Исследование волн сжатия в солнечной короне с помощью КУФ наблюдений

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Аннотация. ***Введение.*** Представлен метод наблюдения волн сжатия в солнечной короне в крайнем ультрафиолетовом диапазоне (КУФ). ***Цель.*** Получение временного сигнала с двумя периодами, которые наблюдаются в глобальном вейвлете. ***Материалы и методы.*** Для анализа используются данные с космического аппарата Solar Dynamics Observatory (SDO), а также наборы библиотек Sunpy и Scalogram.***Результаты и обсуждение.*** На основе одной из работ апробирован метод наблюдения, в результате было показано наличие квазипериодических осцилляций, характерных для волн сжатия ***Заключение.*** Квазипериодические осцилляции послужили основой нового подхода к пониманию природы волн сжатия.

Ключевые слова: Солнце, солнечная корона, волны сжатия, наблюдение волн, SDO, временные сигналы, вейвлет анализ

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Research article

Study of compressive waves in the solar corona using EUV observations

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Abstract. ***Introduction.*** A method for observing of compressive waves in the solar corona in the extreme ultraviolet (EUV) range is presented. ***Goal.*** Obtaining a time signal with two periods that are observed in the global wavelet ***Materials and methods.*** The analysis uses data from the Solar Dynamics Observatory (SDO) spacecraft, as well as the Sunpy and Scalogram library sets. ***Results and discussion.*** Based on one of the works, an observation method was tested, as a result of which the presence of quasi-periodic oscillations characteristic of compressive waves was demonstrated ***Conclusion.*** Quasi-periodic oscillations have formed the basis for a new approach to understanding the nature of compression waves..
Key words: Sun, solar corona, compressive waves, wave observation, SDO, time signals, wavelet analysis
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Введение. На сегодняшний день существует много космических и наземных аппаратов, которые позволяют исследовать Солнце в разных диапазонах электромагнитного спектра. Например, на SDO (Solar Dynamics Observatory) имеются телескопы, которые позволяют наблюдать на Солнце различные процессы, от пятен до вспышек. Этот комплексный подход, при котором один аппарат одновременно наблюдает Солнце в разных диапазонах, является ключевым для современной гелиофизики. Наблюдение на его основе волн в атмосфере Солнца расширяет возможности корональной сейсмологии

В солнечной короне в КУФ-диапазоне с помощью космических аппаратов, например, AIA/SDO, наблюдаются распространяющиеся возмущения интенсивности излучения, которые интерпретируются как волны сжатия. Их регистрируют как в активных областях, так и в корональных дырах, для их описания используют теорию неадиабатических медленных магнитоакустических или акустических волн (Sharma *et al*. 2020). Важность этого явления обусловлена возможной причастностью волн сжатия к нагреву корональной плазмы, Волны сжатия могут использоваться также для решения задач корональной сейсмологии, то есть определения параметров плазмы (Stepanov *et al*., 2012). Наблюдение волн сжатия демонстрируют ряд их особенностей: наличие нескольких периодов в вейвлете и их нерегулярность, широкий спектр сигнала и скорость

меньше звуковой. Несколько периодов в вейвлете объясняется наличием квазипериодических колебаний (Gupta, 2014; Pant *et al*., 2015; Banerjee *et al*., 2011); малость скорость в некоторых случаях обосновывается действием эффекта проекции (De Moortel *et al*., 2002), но широкий спектр сигнала и нерегулярность наблюдения периодов не находят должного объяснения.

Материалы и методы исследований. Для наблюдения волн в солнечной короне, существуют различные методики, которые основаны на различных аппаратах и программных комплексах. Например, в статье Meadowcroft and Nakariakov (2025) описан метод, который позволяет достаточно просто его реализовать на практике. При этом нужно учесть множество проблем при наблюдении Солнца в КУФ диапазоне: дифференциальное вращение, угол крена, центрирование изображений и так далее. Для этого исследования данные загружаются из Центра совместных научных операций (JSOC) Стэнфордского университета. Затем данные преобразуются в формат следующего уровня с помощью набора библиотек Sunpy. В результате преобразования обновляются ключевые слова указателя, удаляется угол крена, изображение масштабируется до согласованного пространственного разрешения и центрируется по центру изображения. Наконец, мы вносим поправку на вращение Солнца.

Для апробации программного обеспечения и методики, выбрана работа Krishna Prasad, *et al*., 2011. В данной работе наблюдается полярная область, где эффект вращения незначителен. Наблюдение относится к 20.07.2010 г. в линии 171 Å. Нами была выбрана та же область и точка наблюдения, в результате получен временной сигнал, показанный на рисунке 1.

Рисунок 1 - Детрендированный сигнал из работы Krishna Prasad, *et al*., 2011/ Figure 1 - Detrended signal from Krishna Prasad, et al., 2011

Используя вейвлет-анализ, из него можно получить два максимума в глобальном вейвлете, как и в оригинальной работе (рис. 2). «Длинный» период равен 20.5 мин, а «короткий» период – 14.9 мин, они оказываются близки к периодам, указанным в статье.

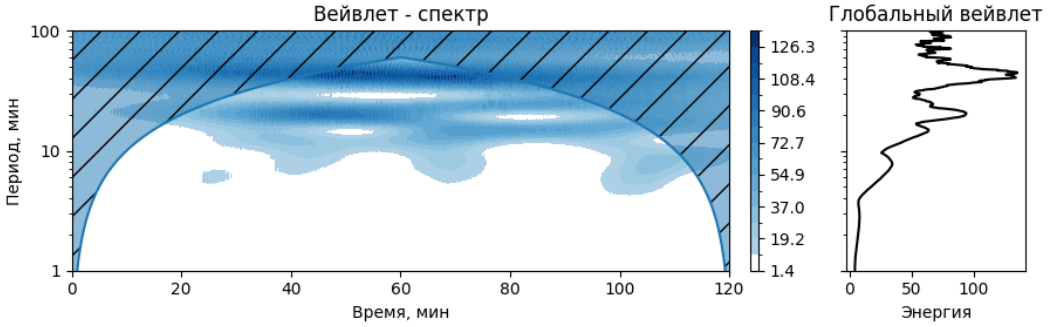

Рисунок 2 - Вейвлет – спектр детрендированного сигнала из работы Krishna Prasad, *et al*., 2011/ Figure 2 - Wavelet – spectrum of a detrended signal from Krishna Prasad, et al., 2011

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Результаты исследований и их обсуждение. Телескоп AIA/SDO предоставляет изображения полного диска Солнца в семи каналах в крайнем ультрафиолетовом диапазоне (EUV) и трёх каналах УФ-видимого диапазона, охватывающих диапазон температур от 6×10^4 К до 2×10^7 К. Прибор регистрирует непрерывные изображения Солнца с пространственным разрешением 1,5’’ и временным разрешением 12 с. Мы выбрали последовательности в диапазонах 171 Å (Рис. 3) и 193 Å (рис. 4), полученные 09 октября 2024 года с 00:00 UT до 01:35 UT с AIA/SDO.

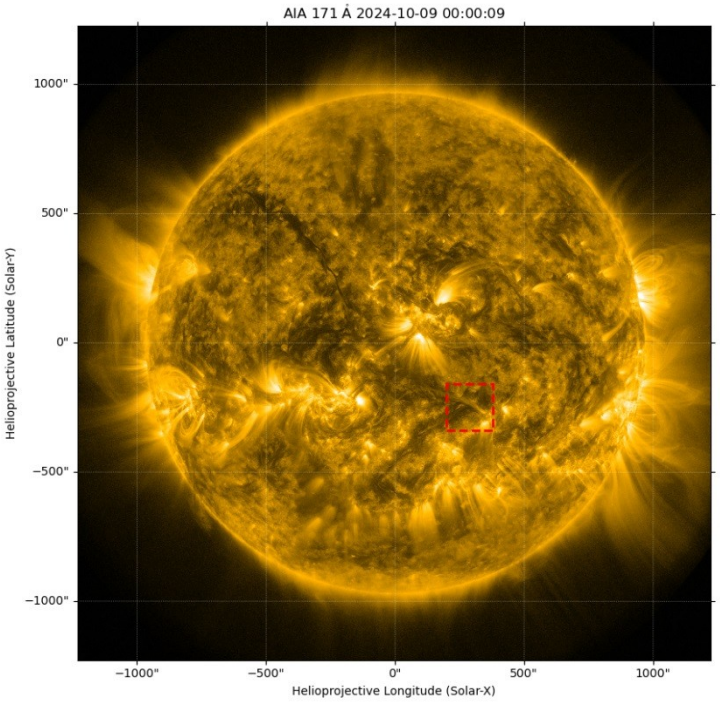

Рисунок 3 - Изображение Солнца в линии 171 Å AIA/SDO от 09 октября 2024 г. Красный квадрат обозначает область, выбранную для наблюдений. https://sdac.virtualsolar.org/cgi/search/ Figure 3 - Image of the Sun in the 171 Å AIA/SDO line from October 9, 2024. The red square indicates the area selected for observation. https://sdac.virtualsolar.org/cgi/search/

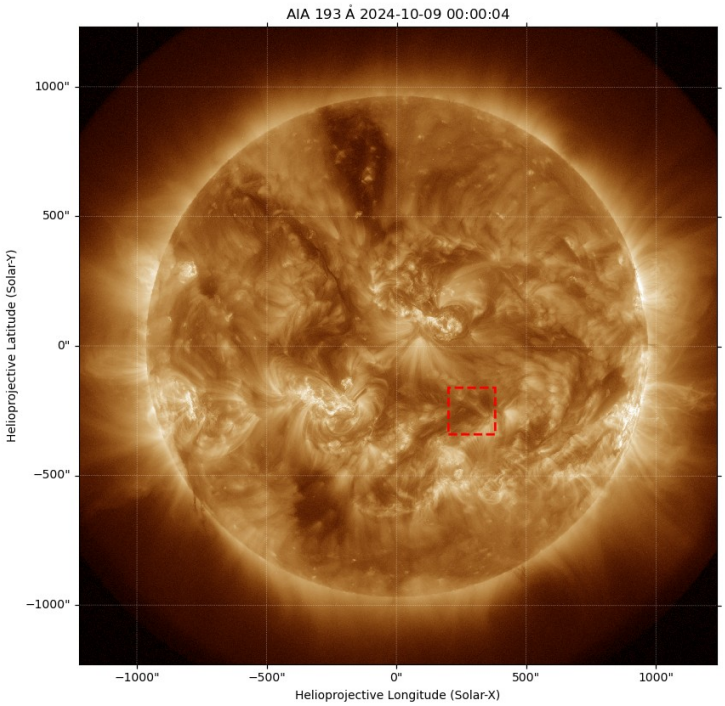

Рисунок 4 - Изображение Солнца в линии 193 Å AIA/SDO от 09 октября 2024 г. Красный квадрат

обозначает область, выбранную для наблюдений. https://sdac.virtualsolar.org/cgi/search/ Figure 4 -Image of the Sun in the 193 Å AIA/SDO line from October 9, 2024. The red square indicates the area selected for observation. https://sdac.virtualsolar.org/cgi/search

Каналу 171 Å соответствует температура около 1 млн К, длине волны 193 Å – около 1.2 млн К. Для наблюдения на солнечном диске была выбрана активная область, показанная на рисунках 1 и 2, она отмечена красным квадратом. Далее вдоль вытянутой корональной структуры, образованной магнитным полем, которая видна ка святящаяся полоса на темном фоне окружающей короны, проводится разрез. Он отмечен зеленным отрезком прямой (рисунки 5 и 6 Объектом нашего изучения будут возмущения КУФ-излучения, распространяющиеся вдоль разреза. Для нашей частной задачи построения временного сигнала берется некоторая точка на разрезе, она отмечена красным кружком. Временной сигнал показан на рисунках 6 и 7. Проведено тестовое построение временного сигнала на примере ранее проведенного исследования. Используются известные алгоритмы обработки данных наблюдений из библиотеки Sunpy. Полученные сигналы демонстрируют наличие квазипериодических осцилляций, характерных для волн сжатия.

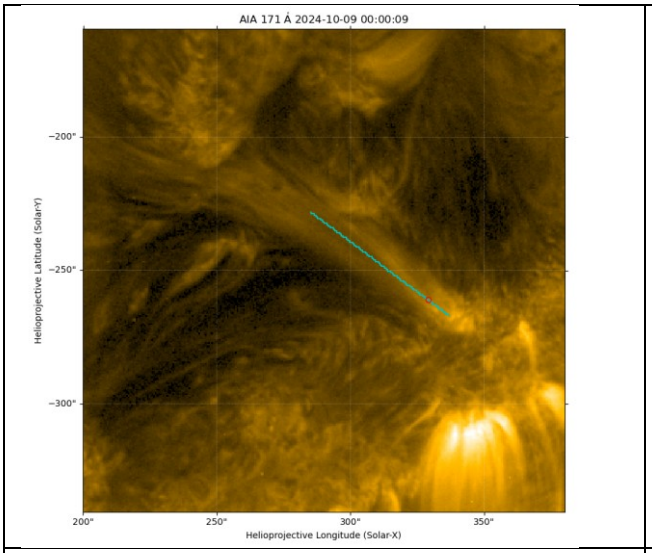

Рисунок 5 - Область на диске Солнца, линия 171 Å./ Figure 5 - Area on the Sun's disk, line 171 Å.

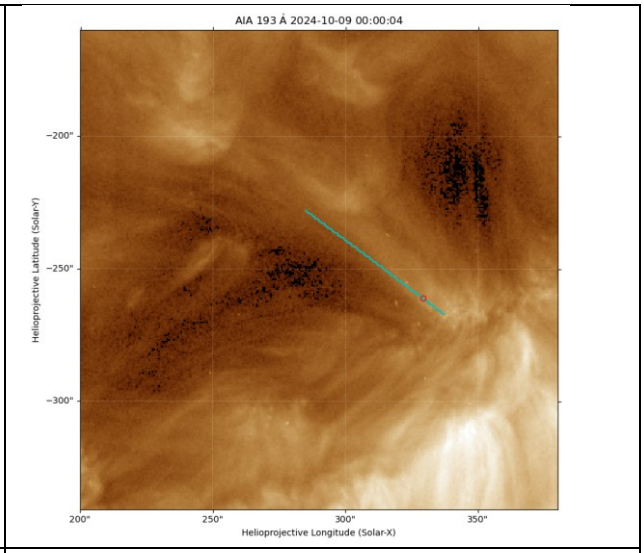

Рисунок 6 - Область на диске Солнца, линия 193 Å./ Figure 6 - Area on the Sun's disk, line 193 Å

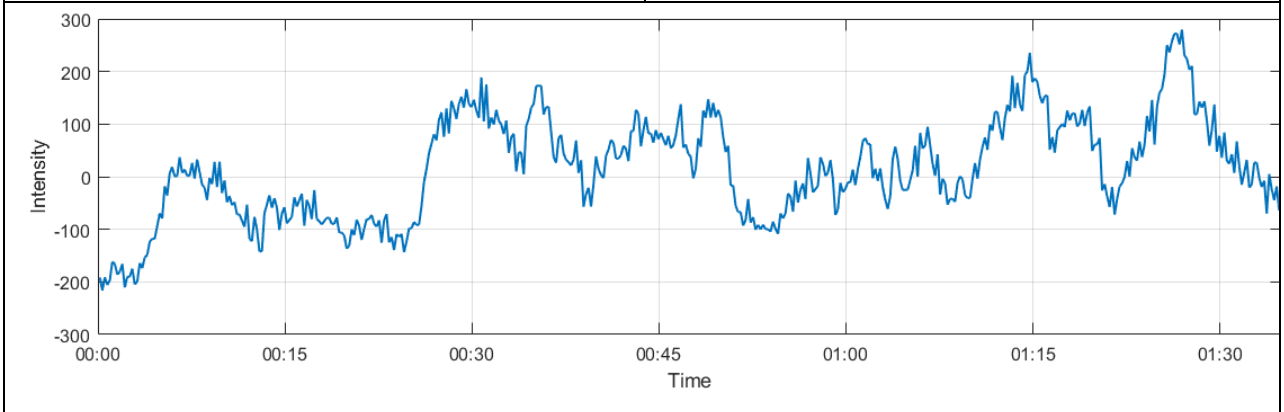

Рисунок 7. Детрендированный сигнал, линия 171 Å./ Figure 7. Detrended signal, line 171 Å.

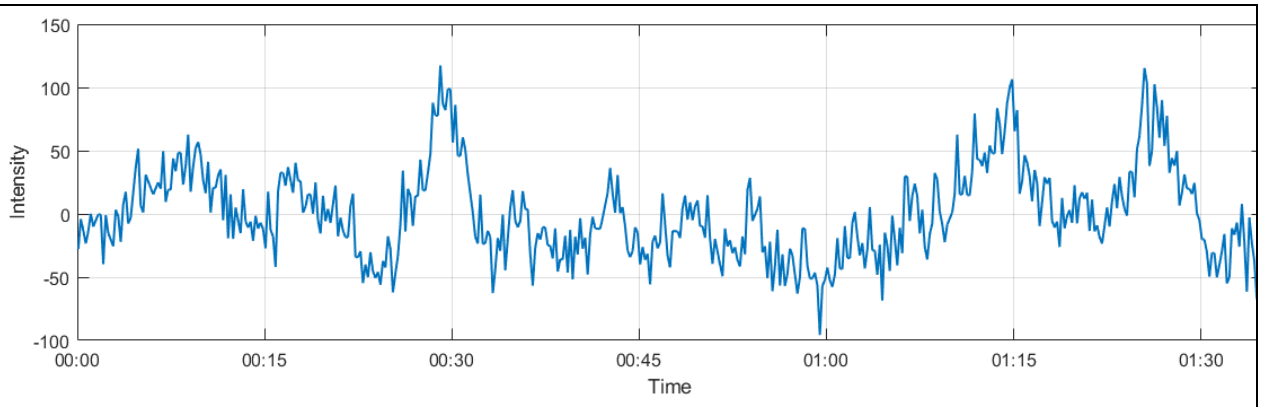

Рисунок 8. Детрендированный сигнал, линия 193 Å./ Figure 7. Signal with a deviation from the trend, line 171 Å

Заключение. В проведенном исследовании отработана методика снятия временного сигнала с изображения Солнца в линиях КУФ-диапазона для изучения волн сжатия. Имеется высокая корреляция между сигналами, полученными в двух линиях. Отметим, что квазипериодические осцилляции послужили основой нового подхода к пониманию природы волн сжатия (Derteev *et al*., 2024). Он заключается в интерпретации всплесков интенсивности излучения как последовательности отдельных, не связанных друг с другом акустических возмущений корональной плазмы.

Список источников

1. Sharma A., Tripathi D., Erdelyi R. et al. Wave amplitude modulation in fan loops as observed by AIA/SDO. Astronomy and Astrophysics. 2020. Vol. 638. A6. https://doi.org/10.1051/0004-6361/201936667
2. Stepanov A.V., Zaitsev V.V., Nakariakov V.M. Coronal Seiamology. WILEY-VCH Verlag, 2012.
3. Gupta G.R. Observations of dissipation of slow magneto-acoustic waves in a polar coronal hole. Astronomy and Astrophysics. 2014. Vol. 568. A96. https://doi.org/10.1051/0004-6361/201323200
4. Pant V., Dolla L., Mazumder R. et al. The Astrophysical Journal. 2015. Vol. 807. No. 71. https://doi.org/10.1088/0004-637X/807/1/71
5. Banerjee D., Gupta G.R., Teriaca L. Propagating MHD Waves in Coronal Holes. Space Science Reviews. 2011. Vol. 158. P. 267-288. https://doi.org/10.1007/s11214-010-9698-z
6. De Moortel I., Ireland J., Hood A.W., Walsh R.W. The detection of 3 & 5 min period oscillations in coronal loops. 2002. Astronomy and Astrophysics. Vol. 387. L13-L16. https://doi.org/10.1051/0004-6361:20020436
7. Meadowcroft R.L., Nakariakov V.M. Fine structuring of slow magnetoacoustic wave periods in a solar coronal fan. MNRAS. 2025. Vol. 536. P. 3192-3199. https://doi.org/ 10.1093/mnras/stae2739
8. Krishna Prasad S., Banerjee D., Gupta G.R. Propagating intensity disturbances in polar corona as seen from AIA/SDO. Astronomy and Astrophysics. 2011. Vol. 528. L4. https://doi.org/ 10.1051/0004-6361/201016405
9. Derteev S.B., Sapraliev M.E., Shividov N.K., Mikhalyaev B.B. Acoustic Waves in a High-Temperature Plasma III. Two-Periodic Disturbances. Solar Physics. 2024. Vol. 299. 141. https://doi.org/ 10.1007/s11207-024-02381-0

References

1. Sharma A., Tripathi D., Erdelyi R. et al. Wave amplitude modulation in fan loops as observed by AIA/SDO. Astronomy and Astrophysics. 2020. Vol. 638. A6. https://doi.org/10.1051/0004-6361/201936667
2. Stepanov A.V., Zaitsev V.V., Nakariakov V.M. Coronal Seiamology. WILEY-VCH Verlag, 2012.

3. Gupta G.R. Observations of dissipation of slow magneto-acoustic waves in a polar coronal hole. Astronomy and Astrophysics. 2014. Vol. 568. A96. https://doi.org/10.1051/0004-6361/201323200
4. Pant V., Dolla L., Mazumder R. et al. The Astrophysical Journal. 2015. Vol. 807. No. 71. https://doi.org/10.1088/0004-637X/807/1/71
5. Banerjee D., Gupta G.R., Teriaca L. Propagating MHD Waves in Coronal Holes. Space Science Reviews. 2011. Vol. 158. P. 267-288. https://doi.org/10.1007/s11214-010-9698-z
6. De Moortel I., Ireland J., Hood A.W., Walsh R.W. The detection of 3 & 5 min period oscillations in coronal loops. 2002. Astronomy and Astrophysics. Vol. 387. L13-L16. https://doi.org/10.1051/0004-6361:20020436
7. Meadowcroft R.L., Nakariakov V.M. Fine structuring of slow magnetoacoustic wave periods in a solar coronal fan. MNRAS. 2025. Vol. 536. P. 3192-3199. https://doi.org/ 10.1093/mnras/stae2739
8. Krishna Prasad S., Banerjee D., Gupta G.R. Propagating intensity disturbances in polar corona as seen from AIA/SDO. Astronomy and Astrophysics. 2011. Vol. 528. L4. https://doi.org/ 10.1051/0004-6361/201016405
9. Derteev S.B., Sapraliev M.E., Shividov N.K., Mikhalyaev B.B. Acoustic Waves in a High-Temperature Plasma III. Two-Periodic Disturbances. Solar Physics. 2024. Vol. 299. 141. https://doi.org/ 10.1007/s11207-024-02381-0

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Прокрастинация и толерантность к неопределенности в современном научном дискурсе

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Аннотация. ***Введение.*** Современная социальная реальность характеризуется высокой степенью неопределенности и непредсказуемости, что существенно повышает требования к адаптационным способностям индивидов. В условиях глобальной нестабильности особое внимание привлекают исследования дезадаптивных поведенческих паттернов, включая феномен прокрастинации. Прокрастинация, как когнитивно-поведенческая стратегия избегания, может приводить к серьезным негативным последствиям, таким как снижение продуктивности, эмоциональное истощение и переживание чувства личной несостоятельности. В основе хронической прокрастинации часто лежит глубинная неспособность индивида эффективно справляться с неопределенностью. Эта взаимосвязь представляет собой важный предмет теоретического анализа, позволяющий глубже понять механизмы формирования прокрастинативного поведения. ***Материалы и методы.*** Методологической основой настоящего теоретического исследования является системный анализ, который позволил рассмотреть феномены прокрастинации и толерантности к неопределенности как сложные, многокомпонентные конструкты, находящиеся в динамическом взаимодействии. В рамках данного подхода был реализован комплексный подход, включающий общенаучные и теоретико-психологические методы, что обеспечило всестороннее изучение исследуемых феноменов и их взаимосвязей. ***Результаты и обсуждение.*** Субъективное отношение личности к различным аспектам человеческого существования представляет собой фундаментальный элемент психической организации, служащий важным связующим звеном между объективными проявлениями психики и внутренней позицией индивида. В контексте данного анализа, прокрастинацию целесообразно рассматривать не как автономный феномен, а скорее, как поведенческий симптом, обусловленный низкой толерантностью к неопределенности. Этот механизм представляет собой специфический способ, посредством которого внутренний дискомфорт, вызванный неясностью и непредсказуемостью, трансформируется в конкретные дезадаптивные действия или, напротив, бездействие ***Заключение.*** Теоретический анализ показал, что низкая толерантность к неопределенности предсказывает прокрастинацию, создавая когнитивно-аффективную основу. Основные механизмы включают тревожность, перфекционизм, ожидания неудачи и дефицит гибкого планирования. Для борьбы с прокрастинацией важен комплексный подход, включающий развитие толерантности к неопределенности. Эффективные методы включают КПТ, тренинги по принятию решений, техники эмоциональной регуляции и экспозиционную терапию. Перспективы исследований включают эмпирическую проверку модели и разработку программ по развитию толерантности к неопределенности.

Ключевые слова: прокрастинация, толерантность к неопределенности, тревожность, перфекционизм, эмоциональная регуляция, принятие решений.

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Research article

Procrastination and Tolerance for Uncertainty in Modern Scientific Discourse

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Abstract. ***Introduction.*** The current social reality is characterized by a high degree of uncertainty and unpredictability, which significantly increases the demands on individuals' adaptive abilities. In the context of global instability, research on maladaptive behavioral patterns, including the phenomenon of procrastination, has gained significant attention. Procrastination, as a cognitive-behavioral avoidance strategy, can lead to serious negative consequences, such as decreased productivity, emotional exhaustion, and feelings of personal failure. Chronic procrastination is often rooted in an individual's underlying inability to effectively cope with uncertainty. This relationship is an important subject of theoretical analysis, allowing us to gain a deeper understanding of the mechanisms that shape procrastination behavior. ***Materials and methods.*** The methodological basis of this theoretical study is systemic analysis, which allowed us to consider the phenomena of procrastination and tolerance to uncertainty as complex, multi-component constructs that are in dynamic interaction. Within this approach, a comprehensive approach was implemented, including general scientific and theoretical-psychological methods, which ensured a comprehensive study of the phenomena under investigation and their relationships. ***Results and discussion.*** The subjective attitude of an individual towards various aspects of human existence is a fundamental element of mental organization that serves as an important link between the objective manifestations of the mind and the individual's internal position. In the context of this analysis, procrastination should be viewed not as an autonomous phenomenon but rather as a behavioral symptom caused by a low tolerance for uncertainty. ***Conclusion.*** A theoretical analysis has shown that low tolerance for uncertainty predicts procrastination, creating a cognitive-affective basis. The main mechanisms include anxiety, perfectionism, expectations of failure, and a lack of flexible planning. A comprehensive approach is important for combating procrastination, including the development of tolerance for uncertainty. Effective methods include CBT, decision-making training, emotional regulation techniques, and exposure therapy. Research prospects include the empirical validation of the model and the development of programs for developing tolerance for uncertainty..

Key words: procrastination, tolerance for uncertainty, anxiety, perfectionism, emotional regulation, and decision-making.
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Introduction. Modern reality is characterized by a high degree of instability and unpredictability, placing increased demands on an individual's ability to function effectively in conditions of uncertainty. In this context, research into maladaptive behavioral patterns, such as procrastination , which can lead to serious negative consequences such as decreased productivity, emotional burnout, and feelings of personal failure, is particularly relevant [1, 3]. Many cases of chronic procrastination are rooted in an individual's fundamental inability to comfortably exist in a situation of uncertainty, making theoretical analysis of the relationship between these two phenomena particularly relevant.

The aim of the study is to carry out a theoretical analysis of modern scientific concepts on procrastination and tolerance of uncertainty, identifying the key mechanisms of their mutual influence and points of contact.

Research Materials and Methods. The methodological basis of this theoretical study was a systems analysis, which allowed us to examine the phenomena of procrastination and tolerance of uncertainty as complex, multicomponent constructs that dynamically interact. To achieve the research goal, a combination of general scientific and theoretical psychological methods was used.

Research Results and Discussion. Procrastination (from the Latin pro – instead of, ahead of, and crastinus – tomorrow) is understood in modern psychology as the conscious, irrational postponement of planned tasks despite an awareness of the negative consequences of such actions [8, 11]. It is not simply laziness or a change in plans, but a complex psychological phenomenon accompanied by a range of negative emotions: guilt, anxiety, and discomfort.

N. Milgram identifies two key areas of procrastination: postponing task completion and postponing decision-making [9]. A typology is also widely used, dividing procrastination into everyday, academic (especially relevant for students), decision-making, neurotic (associated with existential fears), and compulsive (as a stable behavioral pattern). In addition, a distinction is made between normative (episodic) and non-normative (chronic) procrastination, where the latter poses a serious threat to psychological well-being [3].

Theoretical explanations for procrastination can be found in many personality theories.

1. From the point of view of the psychodynamic approach (Blatt, Quinlan), procrastination is considered as a defense mechanism that allows one to avoid anxiety associated with possible failure.
2. Behavioural theory sees it as the result of a lack of positive reinforcement or the presence of negative experiences when performing unpleasant tasks.
3. The cognitive approach emphasizes the role of irrational beliefs such as perfectionism (“all or nothing”) and catastrophizing the consequences of failure, which paralyzes the will to act.
4. Humanistic psychology interprets procrastination as a symptom of incongruence, a gap between the “real self” and the “ideal self,” and also as a consequence of the lack of personal significance of the task being performed.

A unifying model is Ainslie's theory, which explains procrastination as a conflict between immediate reward (the pleasure of delay) and distant but more meaningful goals. This conflict triggers a "vicious cycle": the search for immediate gratification → increased anxiety → increased avoidance.

Tolerance for uncertainty (TU) is the ability of an individual to comfortably exist and act effectively in conditions of insufficient information, ambiguity, and unpredictability of results [1, 28]. The structure of this complex phenomenon includes cognitive (ability to work with contradictory information), emotional (absence of distress in unclear situations), and behavioral (readiness to take action despite uncertainty) components.

Historically, the concept was introduced by E. Frenkel-Brunswik in the late 1940s in the context of studying the authoritarian personality. She linked intolerance to uncertainty with rigidity, black-and-white thinking, and a tendency to simplify complex situations. S. Badner

defined intolerance as the tendency to perceive uncertain situations as a source of threat, and tolerance as the tendency to see them as a welcome challenge [28].

In modern research, TN is considered both a personality trait and a situationally specific attitude. Russian contributions to the study of this phenomenon include the work of T.V. Kornilova, who introduced the concept of "interpersonal intolerance of uncertainty," emphasizing that a person can be tolerant in the professional sphere but experience severe stress from uncertainty in relationships [9].

High levels of TN correlate with creativity, flexible thinking, low anxiety, and effective stress coping strategies. Conversely, intolerance is associated with dogmatism, authoritarianism, increased anxiety, and avoidance behavior.

The conducted analysis allows us to identify several key mechanisms that link procrastination and tolerance of uncertainty into a single behavioral complex.

Anxiety as a mediator. Any task with an unpredictable outcome, complex, or unclear requirements activates a state of uncertainty. For someone with low TN, this state is a powerful stressor, generating high anxiety. Procrastination, in this case, acts as a maladaptive emotional regulation strategy, allowing one to temporarily reduce anxiety by avoiding the stressor. However, in the long term, this leads to an accumulation of problems and an intensification of negative experiences, perpetuating a vicious cycle [12, 27].

Perfectionism and Fear of Failure. Intolerance of uncertainty is often associated with rigid cognitive patterns, among which perfectionism occupies a special place. The belief that the result must be perfect, combined with the inability to predict and guarantee this ideal outcome, generates an intense fear of failure. In such a situation, delaying the start of an activity is perceived as a less painful alternative to a possible "less than perfect" result and the associated criticism [11, 21].

Deficit in planning skills under uncertainty. Effective task execution in a situation of information deprivation requires developed flexible planning skills, the ability to formulate and test hypotheses, and to use trial and error. Individuals with low TN often struggle with this type of activity. Uncertainty paralyzes their ability to formulate even a rough plan of action, making the task itself seem overwhelming and, consequently, prone to postponement.

Impaired decision-making processes. Making decisions under uncertainty is a cognitively complex task. Intolerance of uncertainty directly correlates with difficulties in this area—a tendency to delay decisions, search for redundant information, and getting stuck at the analysis stage of alternatives. Thus, decision-making procrastination is a direct behavioral manifestation of low tolerance for uncertainty [9].

The subjective attitude of an individual to various aspects of a person’s life is one of the key components of his mental organization, serving as a link between the objective manifestations of the psyche and the internal personal position of a person [14].

Thus, procrastination can be viewed not as an independent phenomenon, but often as a behavioral symptom of low tolerance for uncertainty. It is the specific mechanism through which internal discomfort from ambiguity and unpredictability is transformed into specific maladaptive actions (or inactions).

Conclusion. Theoretical analysis confirmed the complexity and close relationship between the phenomena of procrastination and tolerance of uncertainty. Low tolerance of uncertainty creates the psychological foundation for procrastination, serving as one of its key predictors. The main mechanisms underlying this relationship include: the generation of anxiety, increased perfectionistic attitudes and fear of failure, a deficit in flexible planning skills, and disruptions in the decision-making process.

The theoretical findings obtained have important practical implications for psychological counseling and pedagogy. Combating chronic procrastination cannot be reduced to time management alone. It requires developing a fundamental personality trait-tolerance for uncertainty. Effective approaches here may include: cognitive behavioral therapy aimed at correcting perfectionism and catastrophizing; decision-making training in conditions of limited

information; developing emotional regulation and mindfulness skills to reduce anxiety; and the use of exposure therapy methods, where the client is gradually immersed in situations of controlled uncertainty.

The prospects for further research include empirical verification of the proposed theoretical model and the development of comprehensive psychological and pedagogical programs that integrate the development of tolerance to uncertainty as a basis for overcoming destructive procrastination.

Список литература

1. Аристова, И. Л. Исследование академической прокрастинации у студентов вуза / И. Л. Аристова, Н. С. Горбач // Мир педагогики и психологии. 2020. № 4(45). С. 118-125.
2. Реан А.А. Практическая психодиагностика личности: Учеб. пособ. -СПб; Изд-во СПб ун-та, 2001. 224 с
3. Валиуллина Е. В. Локус воспринимаемого контроля и уровень прокрастинации // Концепт. 2018. №8. С. 111–117. URL: http://e-koncept.ru/2018/182017.htm.
4. Гаврильева, З. Н. Толерантность к неопределённостьи в психологической науке / З. Н. Гаврильева // Вестник современных исследований. 2019. № 1.11(28). С. 34-36.
5. Захарцева, А. В. Особенности локуса контроля у студентов, проживающих с родителями и в общежитии / А. В. Захарцева // Социально-психологические вызовы современного общества. Проблемы. Перспективы. Пути развития: Материалы VI Международной научно-практической конференции, Брянск, 22 апреля 2021 года. Брянск: Брянский государственный университет имени академика И.Г. Петровского, 2021. С. 128-131.
6. Зобнина, Т. В. Исследование локуса контроля у студентов - будущих педагогов / Т. В. Зобнина, Л. П. Кислякова // Педагогика, психология и образование: вызовы и перспективы: Сборник статей по итогам Международной научно-практической конференции, Пермь, 23 августа 2018 года. Пермь: Общество с ограниченной ответственностью "Агентство международных исследований", 2018. С. 36-39.
7. Ильин, А. В. Как работает прокрастинация / А. В. Ильин, М. Н. Сидоренко // Научные исследования 2022: Сборник статей II Международной научно-практической конференции, Пенза, 30 июля 2022 года. Пенза: Наука и Просвещение (ИП Гуляев Г.Ю.), 2022. С. 81-83.
8. Козловская, Д. И. Локус контроля и его взаимосвязь со стремлением к самоактуализации у студентов / Д. И. Козловская, С. Н. Козловская // Ценностные ориентации молодежи в условиях модернизации современного общества: Материалы Всероссийской с международным участием научно-практической конференции, Горно-Алтайск, 12 декабря 2020 года / Под редакцией Г.Ю. Лизуновой. Горно-Алтайск: Горно-Алтайский государственный университет, 2020. С. 356-368.
9. Колесникова, В. И. Теоретический анализ феномена прокрастинации в парадигме глубинной психологии / В. И. Колесникова, Ю. С. Денисенко // Психология и педагогика в Крыму: пути развития. 2020. № 2. С. 155-172.
10. Корнилова Т. В. Новый опросник толерантности-интолерантности к неопределенности // Психологический журнал. 2010, том 31, № 1, с. 74–86
11. Матинова, Е. В. Понятие прокрастинации в психологии / Е. В. Матинова // Проблемы и перспективы развития России: Молодежный взгляд в будущее: Сборник научных статей 5-й Всероссийской научной конференции. В 4-х томах, Курск, 20–21 октября 2022 года / Отв. редактор А.А. Горохов. Том 2. – Курск: Юго-Западный государственный университет, 2022. С. 57-59.
12. Репенко, М. С. Толерантность к неопределенности и тревожность как факторы принятия решения в условиях неопределенности / М. С. Репенко, Н. В. Устинова // Личностные и ситуационные детерминанты поведения и деятельности человека: Материалы Международной научно-практической конференции, посвященной 80-летию В.Д. Потаповой, Донецк, 08 декабря 2022 года. – Донецк: Донецкий национальный университет, 2022. С. 115-120.
13. Рооз, В. С. Толерантность к неопределенности и психологическое здоровье подростков / В. С. Рооз // Аспирант. 2021. № 1(58). С. 200-202.

14. Ряжкин, А. О. Особенности субъективного отношения личности к значимым ценностям у студентов вуза / А. О. Ряжкин // Вестник Мининского университета. 2022. Т. 10, № 3(40). DOI 10.26795/2307-1281-2022-10-3-10.
15. Юдеева Т. Ю., Гаранян Н. Г., Жукова Д. Н. Апробация опросника студенческой прокрастинации // Психологическая диагностика. 2011, № 2. С. 84-94.
16. Doğanülkü, H., Korkmaz, O., Griffiths, M., & Pakpour, A. (2021). Fear of COVID-19 lead to procrastination among Turkish university students: The mediating role of intolerance of uncertainty. BMC Psychology, 9. https://doi.org/10.1186/s40359-021-00681-9
17. Azimi, S., Milne, G., & Miller, E. (2020). Why do consumers procrastinate and what happens next?. Journal of Consumer Marketing. https://doi.org/10.1108/jcm-07-2019-3329
18. Vives, M., & FeldmanHall, O. (2018). Tolerance to ambiguous uncertainty predicts prosocial behavior. Nature Communications, 9. https://doi.org/10.1038/s41467-018-04631-9
19. Sagone, E., & Indiana, M. (2023). The Roles of Academic Self-Efficacy and Intolerance of Uncertainty on Decisional Procrastination in University Students during the COVID-19 Pandemic. Education Sciences. https://doi.org/10.3390/educsci13050476 (2022). Role of Decision-Making Styles and Intolerance of Uncertainty on Procrastination During the Pandemic.
20. Journal of Higher Education Theory and Practice. https://doi.org/10.33423/jhetp.v22i17.5655 Lillemo, S. (2014). Measuring the effect of procrastination and environmental awareness on households' energysaving behaviours: An empirical approach. Energy Policy, 66, 249-256. https://doi.org/10.1016/j.enpol.2013.10.077
21. Miller, A., Bravo, D., Arnold, E., Rincon, B., & Murray, C. (2024). Examining social support and procrastination among college students. Frontiers in Psychology, 15. https://doi.org/10.3389/fpsyg.2024.1425524
22. Khoury-Malhame, M., Malhab, S., Chaaya, R., Sfeir, M., & Khoury, S. (2024). Coping during socio-political uncertainty. Frontiers in Psychiatry, 14. https://doi.org/10.3389/fpsyt.2023.1267603
23. Lim, A., & Javadpour, S. (2021). Into the Unknown: Uncertainty and Procrastination in Students From a Life History Perspective. Frontiers in Psychology, 12. https://doi.org/10.3389/fpsyg.2021.717380
24. Fourtounas, A., & Thomas, S. (2016). Cognitive factors predicting checking, procrastination and other maladaptive behaviours: Prospective versus Inhibitory Intolerance of Uncertainty. Journal of Obsessive-Compulsive and Related Disorders, 9, 30-35. https://doi.org/10.1016/j.jocrd.2016.02.003

References

1. Aristova, I. L. Issledovanie akademicheskoi prokrastinatsii u studentov vuza / I. L. Aristova, N. S. Gorbach // Mir pedagogiki i psikhologii. – 2020. – № 4(45). – S. 118-125.
2. Rean A.A. Practical Personality Diagnostics: Textbook.-SPb; Publishing House of St. Petersburg University, 2001. 224 p.
3. Valiullina Evgeniya Viktorovna Lokus vosprinimaemogo kontrolya i uroven' prokrastinatsii // Kontsept. 2018. №8.
4. Gavril'eva, Z. N. Tolerantnost' k neopredelennost'i v psikhologicheskoi nauke / Z. N. Gavril'eva // Vestnik sovremennykh issledovanii. – 2019. – № 1.11(28). – S. 34-36.
5. Zakhartseva, A. V. Osobennosti lokusa kontrolya u studentov, prozhivayushchikh s roditelyami i v obshchezhitii / A. V. Zakhartseva // Sotsial'no-psikhologicheskie vyzovy sovremennogo obshchestva. Problemy. Perspektivy. Puti razvitiya: Materialy VI Mezhdunarodnoi nauchno-prakticheskoi konferentsii, Bryansk, 22 aprelya 2021 goda. – Bryansk: Bryanskii gosudarstvennyi universitet imeni akademika I.G. Petrovskogo, 2021. – S. 128-131.
6. Zobnina, T. V. Issledovanie lokusa kontrolya u studentov - budushchikh pedagogov / T. V. Zobnina, L. P. Kislyakova // Pedagogika, psikhologiya i obrazovanie: vyzovy i perspektivy: Sbornik statei po itogam Mezhdunarodnoi nauchno-prakticheskoi konferentsii, Perm', 23 avgusta 2018 goda. – Perm': Obshchestvo s ogranichennoi otvetstvennost'yu "Agentstvo mezhdunarodnykh issledovanii", 2018. – S. 36-39.
7. Il'in, A. V. Kak rabotaet prokrastinatsiya / A. V. Il'in, M. N. Sidorenko // Nauchnye issledovaniya 2022: Sbornik statei II Mezhdunarodnoi nauchno-prakticheskoi konferentsii, Penza, 30 iyulya 2022 goda. – Penza: Nauka i Prosveshchenie (IP Gulyaev G.YU.), 2022. – S. 81-83.

8. Kozlovskaya, D. I. Lokus kontrolya i ego vzaimosvyaz' so stremleniem k samoaktualizatsii u studentov / D. I. Kozlovskaya, S. N. Kozlovskaya // Tsennostnye orientatsii molodezhi v usloviyakh modernizatsii sovremennogo obshchestva: Materialy Vserossiiskoi s mezhdunarodnym uchastiem nauchno-prakticheskoi konferentsii, Gorno-Altaisk, 12 dekabrya 2020 goda / Pod redaktsiei G.YU. Lizunovoi. – Gorno-Altaisk: Gorno-Altaiskii gosudarstvennyi universitet, 2020. – S. 356-368.
9. Kolesnikova, V. I. Teoreticheskii analiz fenomena prokrastinatsii v paradigme glubinnoi psikhologii / V. I. Kolesnikova, YU. S. Denisenko // Psikhologiya i pedagogika v Krymu: puti razvitiya. – 2020. – № 2. – S. 155-172.
10. Kornilova T. V. Novyi oprosnik tolerantnosti-intolerantnosti k neopredelennosti // Psikhologicheskii zhurnal. – 2010. – №6.
11. Matinova, E. V. Ponyatie prokrastinatsii v psikhologii / E. V. Matinova // Problemy i perspektivy razvitiya Rossii: Molodezhnyi vzglyad v budushchee : Sbornik nauchnykh statei 5-i Vserossiiskoi nauchnoi konferentsii. V 4-kh tomakh, Kursk, 20–21 oktyabrya 2022 goda / Otv. redaktor A.A. Gorokhov. Tom 2. – Kursk: Yugo-Zapadnyi gosudarstvennyi universitet, 2022. – S. 57-59.
12. Repenko, M. S. Tolerantnost' k neopredelennosti i trevozhnost' kak faktory prinyatiya resheniya v usloviyakh neopredelennosti / M. S. Repenko, N. V. Ustinova // Lichnostnye i situatsionnye determinanty povedeniya i deyatel'nosti cheloveka : Materialy Mezhdunarodnoi nauchno-prakticheskoi konferentsii, posvyashchennoi 80-letiyu V.D. Potapovoi, Donetsk, 08 dekabrya 2022 goda. – Donetsk: Donetskii natsional'nyi universitet, 2022. – S. 115-120.
13. Rooz, V. S. Tolerantnost' k neopredelennosti i psikhologicheskoe zdorov'e podrostkov / V. S. Rooz // Aspirant. – 2021. – № 1(58). – S. 200-202.
14. Ryazhkin, A. O. Osobennosti sub"ektivnogo otnosheniya lichnosti k znachimym tsennostyam u studentov vuza / A. O. Ryazhkin // Vestnik Mininskogo universiteta. – 2022. – T. 10, № 3(40). – DOI 10.26795/2307-1281-2022-10-3-10.
15. Yudeeva T. YU., Garanyan N. G., Zhukova D. N. Aprobatsiya oprosnika studencheskoi prokrastinatsii // Psikhologicheskaya diagnostika. – 2011. – №2.
16. Doğanülkü, H., Korkmaz, O., Griffiths, M., & Pakpour, A. (2021). Fear of COVID-19 lead to procrastination among Turkish university students: The mediating role of intolerance of uncertainty. BMC Psychology, 9. https://doi.org/10.1186/s40359-021-00681-9
17. Azimi, S., Milne, G., & Miller, E. (2020). Why do consumers procrastinate and what happens next?. Journal of Consumer Marketing. https://doi.org/10.1108/jcm-07-2019-3329
18. Vives, M., & FeldmanHall, O. (2018). Tolerance to ambiguous uncertainty predicts prosocial behavior. Nature Communications, 9. https://doi.org/10.1038/s41467-018-04631-9
19. Sagone, E., & Indiana, M. (2023). The Roles of Academic Self-Efficacy and Intolerance of Uncertainty on Decisional Procrastination in University Students during the COVID-19 Pandemic. Education Sciences. https://doi.org/10.3390/educsci13050476 (2022). Role of Decision-Making Styles and Intolerance of Uncertainty on Procrastination During the Pandemic.
20. Journal of Higher Education Theory and Practice. https://doi.org/10.33423/jhetp.v22i17.5655 Lillemo, S. (2014). Measuring the effect of procrastination and environmental awareness on households' energysaving behaviours: An empirical approach. Energy Policy, 66, 249-256. https://doi.org/10.1016/j.enpol.2013.10.077
21. Miller, A., Bravo, D., Arnold, E., Rincon, B., & Murray, C. (2024). Examining social support and procrastination among college students. Frontiers in Psychology, 15. https://doi.org/10.3389/fpsyg.2024.1425524
22. Khoury-Malhame, M., Malhab, S., Chaaya, R., Sfeir, M., & Khoury, S. (2024). Coping during socio-political uncertainty. Frontiers in Psychiatry, 14. https://doi.org/10.3389/fpsyt.2023.1267603
23. Lim, A., & Javadpour, S. (2021). Into the Unknown: Uncertainty and Procrastination in Students From a Life History Perspective. Frontiers in Psychology, 12. https://doi.org/10.3389/fpsyg.2021.717380

24. Fourtounas, A., & Thomas, S. (2016). Cognitive factors predicting checking, procrastination and other maladaptive behaviours: Prospective versus Inhibitory Intolerance of Uncertainty. Journal of Obsessive-Compulsive and Related Disorders, 9, 30-35. https://doi.org/10.1016/j.jocrd.2016.02.003

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Национальная и международная безопасность на рубеже веков: концептуальные связи

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Аннотация: ***Введение.*** В XXI веке проблемы безопасности государства претерпели кардинальные трансформации, обусловленные многообразием, динамичностью и противоречивостью современного мира. Современная эпоха характеризуется вовлечением всего человечества в глобальные процессы, ускоряемые беспрецедентным научно-техническим прогрессом и сопровождающиеся обострением социальных, экономических, сырьевых и иных проблем, приобретающих планетарный масштаб. ***Методология исследования.*** До 1990-х годов исследования в области международной безопасности государства как в отечественной, так и в зарубежной научной литературе были сосредоточены на вопросах, обусловленных усилением взаимозависимости государств и народов мира, глобализацией экономики и появлением оружия массового уничтожения. В этот период особое внимание уделялось вопросам предотвращения глобальных конфликтов и обеспечения стабильности международных отношений. ***Результаты и обсуждения.*** Статья посвящена проблемам и соотношению концептуальных связей национальной и международной безопасности в современном международном миропорядке. ***Заключение.*** Таким образом, анализ трансформаций системы национальной безопасности России последних лет позволяет выявить ключевые тенденции и факторы, определяющие её развитие. Это, в свою очередь, способствует более глубокому пониманию стратегических приоритетов и направлений совершенствования национальной безопасности в условиях динамично меняющегося мира.

Ключевые слова: национальная безопасность, международная безопасность, концептуализация, современный мир, международный миропорядок, геополитика, геостратегия, реализация и защита.
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Research article

National and International Security at the Turn of the Century: Conceptual Connections

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Abstract. ***Introduction.*** Introduction. In the 21st century, the problems of state security have undergone radical transformations due to the diversity, dynamism, and contradictions of the modern world. The current era is characterized by the involvement of all humanity in global processes, which are accelerated by unprecedented scientific and technological progress and are accompanied by the exacerbation of social, economic, raw materials, and other problems that have acquired a planetary scale. ***Research methodology.*** Until the 1990s, research on international security in both domestic and foreign academic literature focused on issues related to the increasing interdependence of states and peoples around the world, the globalization of the economy, and the emergence of weapons of mass destruction. During this period, there was a strong emphasis on preventing global conflicts and ensuring the stability of international relation. ***Results and discussion.*** The article is devoted to the problems and correlation of conceptual links between national and international security in the modern international world order. ***Conclusion.*** Thus, the analysis of the transformations of Russia's national security system in recent years allows us to identify key trends and factors that determine its development. This, in turn, contributes to a deeper understanding of strategic priorities and directions for improving national security in a dynamically changing world.

Key words: national security, international security, conceptualization, modern world, international world order, geopolitics, geostrategy, implementation, and protection.
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Introduction. National security issues in the 21st century have acquired fundamentally new dimensions in the modern world, which is diverse, dynamic, and full of acute contradictions. Today's life is characterized by the involvement of all humanity in global processes accelerated by unprecedented scientific and technological progress, the exacerbation of social, economic, raw materials, and other problems that are becoming global in nature. Until the 1990s, scientific literature in our country and abroad primarily focused on issues of international national security. This was explained by the growing interdependence of various states and peoples around the world, the internationalization of the economy, and the emergence of global weapons of mass destruction. The global threat to humanity from industrial activity has also increased.

Research Methodology. In political science, international security is considered a state of political, economic, and other relations between states that eliminates the threat of aggression by one or a group of states against another state or group of states and ensures their peaceful

coexistence based on the principles of equality, non-interference in each other's internal affairs, respect for the national independence and self-determination of peoples, and their free development on a democratic basis. The theory and practice of security in the modern world have primarily focused on the development of state security. The concept of state security as a system of measures to protect the interests of the country, society, and individuals officially entered political practice in the Russian Federation only in 1992 with the adoption of the Law "On Security." In theoretical works and journalism in Russia up to the present day, this concept has been defined by the term "national security," borrowed from US political science. This legal act, as well as subsequent documents that presented a multifaceted interpretation of the concept of security, became the basis for the further development of the relevant doctrine. In 1993, the term "national security" was institutionalized in Russian theoretical research, marking an important stage in understanding this phenomenon. From this point on, active work began on conceptualizing and methodologically fleshing out this concept, contributing to the development of a comprehensive system for ensuring national security in the Russian Federation.

Moreover, this concept is understood quite differently by Russian international relations specialists, who understand national security and its essence within the state, while those who deal with Russia's domestic affairs interpret it as national security, primarily as peace between nations and nationalities. Some scholars seek to view national security as a combination of the security of the individual, society, and the state, on the grounds that Russian law classifies them as security entities. In our view, it would be appropriate to distinguish the security of the Russian state as a security entity as a separate category, defining it, given the country's multinational nature, as national-state security.

For example, in the American tradition, according to Act No. 257 of 1947, "national security" in official American sources is understood as a condition of state functioning resulting from defensive measures that increase the state's invulnerability to external or internal threats, whether overt or subversive. This approach to state security (in the United States, the concept of "nation" is equated with the state) stems from the postulate that international relations result from the clash of states, which, relying on their available resources, pursue their goals of both security and expansion.

Results and discussion. It should be noted that, until recently, the world's leading states focused primarily on military security. However, in the 1960s, politicians and society at large gradually began to recognize that threats to the existence of human civilization stem not only from nuclear and other weapons of mass destruction, but also from human activity itself. Therefore, true security in our time can only be ensured through a comprehensive approach, encompassing all spheres of public life—state, society, and the individual. Security policy must include a system of measures that address the causes of all types of danger facing humanity.

All the diversity of life activities of the state and society can be divided into the following areas (spheres):

- political;
- economic;
- social and environmental.

To ensure the progressive development of social relations in the Russian Federation, it is essential to integrate an innovative approach into public policy. This will not only preserve social stability but also guarantee a high level of national security. At the beginning of the 21st century, the country faced, and continues to face, two strategically significant challenges requiring a comprehensive solution. On the one hand, it is essential to ensure a stable social position for the majority of citizens, which is a fundamental condition for maintaining social harmony. On the other hand, the country's top political leadership is committed to finding innovative, unconventional development paths that build on the social harmony already achieved. A

harmonious combination and successful resolution of these two objectives are key factors in the formation of a sustainable national security model for the Russian Federation and will also contribute to strengthening its position in the international community of highly developed countries. The transformation of Russia's national security system in recent years represents a complex and multifaceted process that requires in-depth analysis to identify the cause-and-effect relationships and factors determining the current security paradigm. Studying these transformations allows us not only to understand the content of new doctrinal documents, but also to identify the intellectual and innovative components that shape the strategic potential of national security in modern Russia.

The genesis of the concept of "national security" in Russia can be structured into several key stages. According to researcher A.V. Voznyuk, the concept was only beginning to emerge in the 19th century, reflecting the first attempts to understand and systematize the threats facing the state. This stage is characterized by a gradual recognition of the need for a comprehensive approach to ensuring security, encompassing military, economic, political, and social aspects.

The further development of the concept of national security in Russia began in the 20th century, a time of significant changes in the international situation and the country's domestic politics. During this period, key theoretical approaches to defining national security emerged, taking into account both external and internal challenges. Particular attention was paid to issues of sovereignty, territorial integrity, and economic stability.

Current transformations of Russia's national security system are driven by globalization, technological progress, and changing geopolitical circumstances. In the context of globalization, the role of international security is increasing, requiring coordinated efforts at the interstate level. Technological progress, in turn, creates both new opportunities and new threats, requiring an adequate response and adaptation of existing doctrinal approaches.

Theoretically, the protective sphere of state activity is an integral part of the political sphere of state and society. However, historically, military issues have been distinguished as a separate sphere of state and society. Each of the above-mentioned spheres of state and society activity corresponds to its own type of security (political, military, economic, social, and environmental). This approach to dividing security into types according to spheres of state activity is also evident in the Law "On Security" of the Russian Federation, which states that security is achieved through the implementation of a unified state policy in the field of security, a system of economic, political, organizational, and other measures adequate to threats to the vital interests of the individual, society, and the state. Thus, the complexity of defining the term "security" lies in the fact that it must encompass two philosophical categories—the category of preservation (stability) and the category of development (variability), which, as is well known, exist in a dialectical unity. Thus, preservation (stability) is inherently conservative, whereas development presupposes variability, which fundamentally excludes stability. In other words, to initiate development, it is necessary to remove the protective barriers and disrupt the established stability of the system. Conversely, to achieve stability, it is necessary to halt development and eliminate the possibility of any change, including those related to development. In this regard, it appears that it is precisely the disruption of the dialectical balance between these two fundamental principles, as well as the skillful exploitation of this imbalance by Russia's geopolitical adversaries, that is at play.

Conclusion.

State security challenges in the 21st century have become multifaceted and complex, requiring an interdisciplinary approach and coordinated efforts at the global level. In the face of growing challenges, it is essential to develop scientific research in the field of international security, with a particular focus on environmental aspects and sustainable development.

Список источников

1. Конституция Российской Федерации (принята на всенародном голосовании 12 декабря 1993 г.) // Российская газета. 1993. 25 декабря. № 237. 3-7 с.
2. Закон РФ от 05.03.1992 № 2446-1 (ред. от 26.06.2008) «О безопасности» // Российская газета. 1992. 6 мая. № 103. 1-10 с.
3. Указ Президента Российской Федерации от 12 мая 2009 г. N 537 "О Стратегии национальной безопасности Российской Федерации до 2020 года" // Российская газета. 2009. 19 мая № 4912.
4. Безопасность России: правовые, социально-экономические и национально-технические аспекты. Словарь терминов и определений [К.В. Фролов и др.]. М., 2024. 361 С.
5. Бойко Ю.П. Историко-теоретические аспекты взаимосвязей нации и государства // История государства и права. 2020. № 2. 25-27 с.
6. Вишняков В.Г. О методологических основах правового регулирования проблем безопасности Российской Федерации // Журнал российского права. 2023. № 9. 13-15 с.
7. Возженников А.В. Национальная безопасность России: методология исследования и политика обеспечения. М., 2022. 424 с.
8. Михайлов А.Е. О понятии «государственная безопасность» и ее принципах // Актуальные проблемы государственной безопасности Российской Федерации: сб. тр. научн. конф. / Рост. гос. ун-т. путей сообщения. Ростов на Дону. 2023. 132-133 с.
9. Мурадян Э.Р. Концепция безопасности личности, общества и государства // Вестник Челябинского государственного университета. Право. Вып. 19. 2024. № 10.
10. Опалев А.В. О некоторых базовых критериях Закона Российской Федерации «О безопасности» и Концепции национальной безопасности Российской Федерации // ФСБ России. Правовое регулирование деятельности федеральной службы безопасности по обеспечению национальной безопасности Российской Федерации: Научно-практический комментарий / Под ред. В.Н. Ушакова, И.Л. Трунова. М., 2023. 592 с.
11. Патрушев Н.П. Особенности современных вызовов и угроз национальной безопасности России // Журнал российского права. 2007. № 7. , 5-8 с.
12. Журинов М. Ж., Пронин Э. А. Глобальная конфликтология: политика и национальная безопасность: Монография. [Текст] / М. Ж. Журинов, Э. А. Пронин НОАНО ВПО Социальный институт экономической безопасности Домодедово: Изд-во СПИЭП, 2016.-237
13. Морозова Г. П., Пронин Э. А., Александров Д. Н., Гезалова А. А., Петров А. А. Информационная экология: монография. - М.: Полиграф сервис 2019. - 530 с.

References

1. Konstitutsiya Rossiiskoi Federatsii (prinyata na vsenarodnom golosovanii 12 dekabrya 1993 g.) // Rossiiskaya gazeta. 1993. 25 dekabrya. № 237. 3-7 s.
2. Zakon RF ot 05.03.1992 № 2446-1 (red. ot 26.06.2008) «O bezopasnostI» // Rossiiskaya gazeta. 1992. 6 maya. № 103. 1-10 s.
3. Ukaz Prezidenta Rossiiskoi Federatsii ot 12 maya 2009 g. N 537 "O Strategii natsional'noi bezopasnosti Rossiiskoi Federatsii do 2020 goda" // Rossiiskaya gazeta. 2009. 19 maya № 4912.
4. Bezopasnost' Rossii: pravovye, sotsial'no-ehkonomicheskie i natsional'no-tekhnicheskie aspekty. Slovar' terminov i opredelenii [K.V. Frolov i dr.]. M., 2024. 361 S.
5. Boiko YU.P. Istoriko-teoreticheskie aspekty vzaimosvyazei natsii i gosudarstva // Istoriya gosudarstva i prava. 2020. № 2. 25-27 s.
6. Vishnyakov V.G. O metodologicheskikh osnovakh pravovogo regulirovaniya problem bezopasnosti Rossiiskoi Federatsii // Zhurnal rossiiskogo prava. 2023. № 9. 13-15 s.
7. Vozzhenikov A.V. Natsional'naya bezopasnost' Rossii: metodologiya issledovaniya i politika obespecheniya. M., 2022. 424 s.
8. Mikhailov A.E. O ponyatii «gosudarstvennaya bezopasnost'» i ee printsipakh // Aktual'nye problemy gosudarstvennoi bezopasnosti Rossiiskoi Federatsii: sb. tr. nauchn. konf. / Rost. gos. un-t. putei soobshcheniya. Rostov na Donu. 2023. 132-133 s.
9. Muradyan EH.R. Kontseptsiya bezopasnosti lichnosti, obshchestva i gosudarstva // Vestnik Chelyabinskogo gosudarstvennogo universiteta. Pravo. Vyp. 19. 2024. № 10. Novoselov S.V. Natsional'naya bezopasnost': nauchnyi aspekt // Chelovek. Soobshchestvo. Upravlenie. 2022. № 1. 32-33 s.

10. Opalev A.V. O nekotorykh bazovykh kriteriyakh Zakona Rossiiskoi Federatsii «O bezopasnostI» i Kontseptsii natsional'noi bezopasnosti Rossiiskoi Federatsii // FSB Rossii. Pravovoe regulirovanie deyatel'nosti federal'noi sluzhby bezopasnosti po obespecheniyu natsional'noi bezopasnosti Rossiiskoi Federatsii: Nauchno-prakticheskii kommentarii / Pod red. V.N. Ushakova, I.L. Trunova. M., 2023. 592 s.
11. Patrushev N.P. Osobennosti sovremennykh vyzovov i ugroz natsional'noi bezopasnosti Rossii // Zhurnal rossiiskogo prava. 2007. № 7. , 5-8 s.
12. Zhurinov M. ZH., Pronin EH. A. Global'naya konfliktologiya: politika i natsional'naya bezopasnost': Monografiya. [Tekst] / M. ZH. Zhurinov, EH. A. Pronin NOANO VPO Sotsial'nyi institut ehkonomicheskoi bezopasnosti Domodedovo: Izd-vo SPIEHP, 2016.-237
13. Morozova G. P., Pronin EH. A., Aleksandrov D. N., Gezalova A. A., Petrov A. A. Informatsionnaya ehkologiya: monografiya. - M.: Poligraf servis 2019. - 530 s.

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Изучение проблемы открытого магнитного потока по данным различных обсерваторий

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Аннотация. ***Введение.*** Магнитное поле короны Солнца имеет прямое отношение к явлениям солнечной активности, в том числе к вспышкам и корональным выбросам массы. Оно также непосредственно связано с формированием постоянно исходящих потоков солнечной плазмы, называемых солнечным ветром. В частности, источники солнечного ветра концентрируются в областях так называемого открытого магнитного поля. Структура поля, расположение и форма его линий влияют на величину скорости потоков плазмы. В связи с этим большое значение приобретает проверка величины открытого магнитного потока, найденного с помощью расчетов, со значением, полученным из прямых наблюдений. ***Цель.*** Сравнить результаты расчетов магнитного потока с полученных данных из различных обсерваторий ***Материалы и методы.*** В настоящей работе проверка между данными проводится на основе фотосферных магнитных карт, построенных с помощью наземных телескопов, Кисловодской астрономической станции и GONG, в 2024 г. ***Результаты и обсуждение.*** Расчеты показали, что расхождение между наблюдаемым и расчетным открытым магнитным потоком значительное, характерное для максимума солнечной активности. ***Заключение.*** По всей видимости, точности потенциальной модели недостаточно для получения адекватного коронального магнитного поля, позволяющего учесть открытый магнитный поток в полной мере.

Ключевые слова: Открытый магнитный поток, физика плазмы, корональное магнитное поле, солнечная корона, магнитные карты фотосферы, Солнце

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Research article

Study of the problem of open magnetic flux based on the data from various observatories

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Abstract. ***Introduction.*** The magnetic field of solar corona is directly related to solar activity, including flares and coronal mass ejections. It is also directly linked to the formation of the constantly outgoing streams of solar plasma, known as the solar wind. Specifically, solar wind sources are concentrated in regions of the so-called open magnetic field. The structure of field, location, and shape influence the speed of the plasma streams. Therefore, it is crucial to compare the calculated open magnetic flux with the value obtained from direct observations. ***Goal.*** Compare the results of magnetic flux calculations with the data obtained from various observatories ***Materials and methods.*** In this paper, the data validation is carried out using photospheric magnetic maps constructed using ground-based telescopes, the Kislovodsk Astronomical Station and GONG, in 2024. ***Results and discussion.*** Calculations have shown that the discrepancy between the observed and calculated open magnetic flux is significant, typical for the maximum of solar activity. ***Conclusion.*** Apparently, the accuracy of the potential model is not sufficient to obtain an adequate coronal magnetic field that would allow the open magnetic flux to be taken into account fully.

Key words: Open magnetic flux, plasma physics, coronal magnetic field, solar corona, photospheric magnetic maps, Sun

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Introduction. Open magnetic fields on the Sun are characterized by the fact that the field lines originate on its surface (the photosphere) and extend far into space. Their study is important because they reveal the large-scale structure of the solar magnetic field and form stable connections between the Sun and the interplanetary medium, determining the geometry of the solar wind flow, as well as its sources on the Sun [1]. Systematic studies of the open field began with the construction of simple potential models of the field in the corona [2-4] based on maps of the photospheric field, initially obtained using ground-based observations [5-6]. The Wilcox observatories are widely known Solar Observatory (WSO) in the United States, an international network of ground-based observatories Global Oscillations Network Group (GONG), as well as the Kislovodsk Mountain Astronomical Station, where the Solar Telescope for Operational Forecasts (STOP) is installed. Currently, solar magnetic field observations are conducted using magnetographs installed on spacecraft, such as Solar Dynamics Observatory (SDO). The OMNI spacecraft observe the interplanetary field at a distance of 1 AU. The aim of this work is to study the problem of open magnetic flux (OMF) and to verify the results using data from the Global observatories.

Oscillation Network Group (GONG) and the Kislovodsk Mountain Astronomical Station (GAS GAO) of the Russian Academy of Sciences .

Materials and methods of research. Direct observation of the interplanetary field allows us to test open field models for their agreement with observational data. The main criterion for testing is the magnitude of the total magnetic flux of the open field. In this case, the field of different directions, from the source and to the source, is taken into account. The magnetic flux calculated in this way is called unsigned. The first measurements until about 1997 showed good agreement between the average model values of the field strength calculated using coronal models (Potential Field Surface , PFSS and MHD) [7-8], which use identical input maps of the photospheric magnetic field and observations in situ at a distance of 1 AU [9-11]. However, later observations revealed a discrepancy, and over the next two decades, model and in- obtained In situ unsigned open flux values have not been consistent and show discrepancies reaching a factor of 2 or more during solar maximums. Currently, heliospheric scientists are noting the existence of a missing flux problem. Proposed sources of the missing flux include, for example, problems with photospheric magnetic field measurements [12], incorrect estimates of the polar magnetic field [13], unaccounted for magnetic fields from coronal mass ejections, as well as the time-dependent nature of the magnetic field and the methodologies for estimating the total open flux from in situ observations. Arge *et al* . [11] suggest that the boundaries of coronal holes observed in the extreme ultraviolet are merely the boundaries of a long-term open field. Beyond these boundaries, and in the region of the apparently closed field, there is a layer of a constantly evolving mixture of open and closed fields with a width of about one or two supergranules.

Sun service is used to perform coronal field calculations. Gazers [14], using data from the Kislovodsk Mountain Astronomical Station. A PFSS model of the coronal field is constructed using photospheric magnetic field maps obtained from magnetograph observations. The coronal field is constructed similarly using GONG magnetic maps. Magnetic field lines are traced in two directions, from the solar surface to the source surface and vice versa. This allows for the magnetic flux to be fully accounted for. Field lines emanating from the solar surface, i.e., "outward" lines, and those entering the solar surface, i.e., "inward" lines, are considered. Thus, the total field flux is taken into account, regardless of its direction, or the unsigned magnetic flux.

Results and discussion. The most plausible reason for the discrepancy in the MPE calculations is the inaccuracy of the coronal field models calculated from photospheric maps, of which there are several. As noted above, the simplest of these is the PFSS model of a potential field with a radial direction on the source surface. Although the most accurate and complex dynamic MHD models will be required to finally reconcile theory and data, it is worth noting that PFSS models, such as WSA, with all the permissible simplifications, remain extremely effective for studying and understanding the complex relationship between the Sun and the heliosphere. In this paper, we verify the results of the MPE comparison using data from the Global observatories. Oscillation Network Group (GONG) and the Kislovodsk Mountain Astronomical Station of the Main Astronomical Observatory of the Russian Academy of Sciences. The validity of this hypothesis is further confirmed by comparing the morphology of coronal holes obtained by PFSS magnetic line tracing with coronal holes observed in ultraviolet light using the Atmospheric Imaging Assembly on board the Solar Dynamics Observatory (AIA / SDO) ultraviolet telescope.

For comparison, Figure 1 shows an image of a large coronal hole obtained on February 1, 2024, in the 193 Å line with the SDO / AIA ultraviolet telescope. The coronal hole serves as an indicator of a large open-field region, constructed from the GONG map, marked in red. The locations of the coronal hole and the open-field region coincide with minor variations. Figure 2 shows an example of the calculation of the open coronal magnetic field obtained from the GONG photospheric maps.

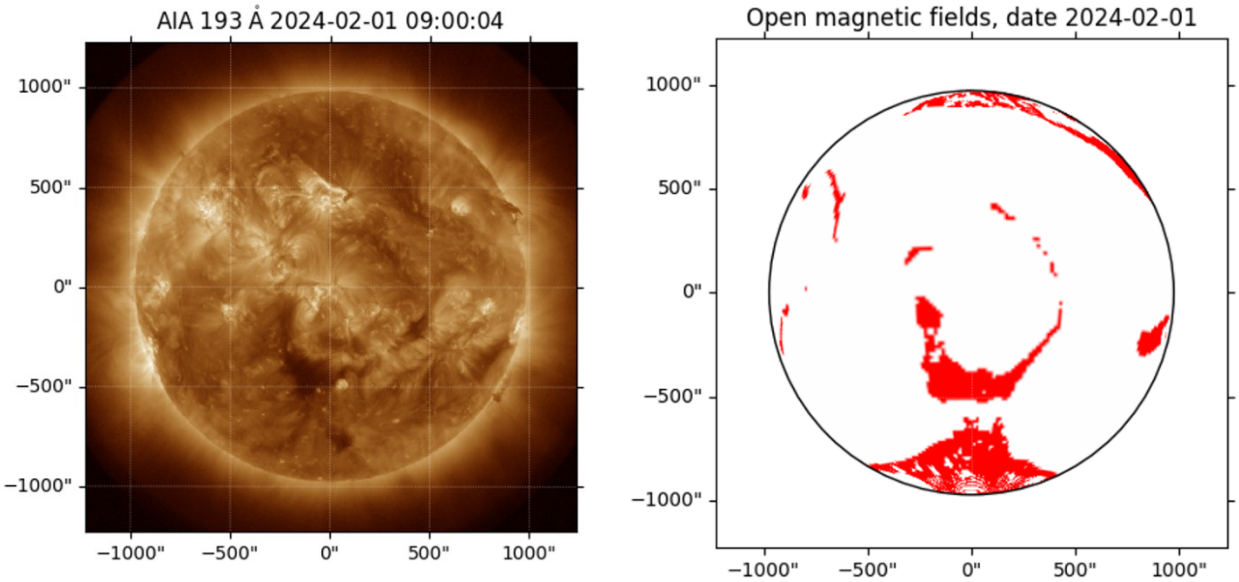

Fig. 1- A coronal hole image obtained with AIA / SDO (left). An example of an open-field region on the photosphere obtained from GONG data (right).

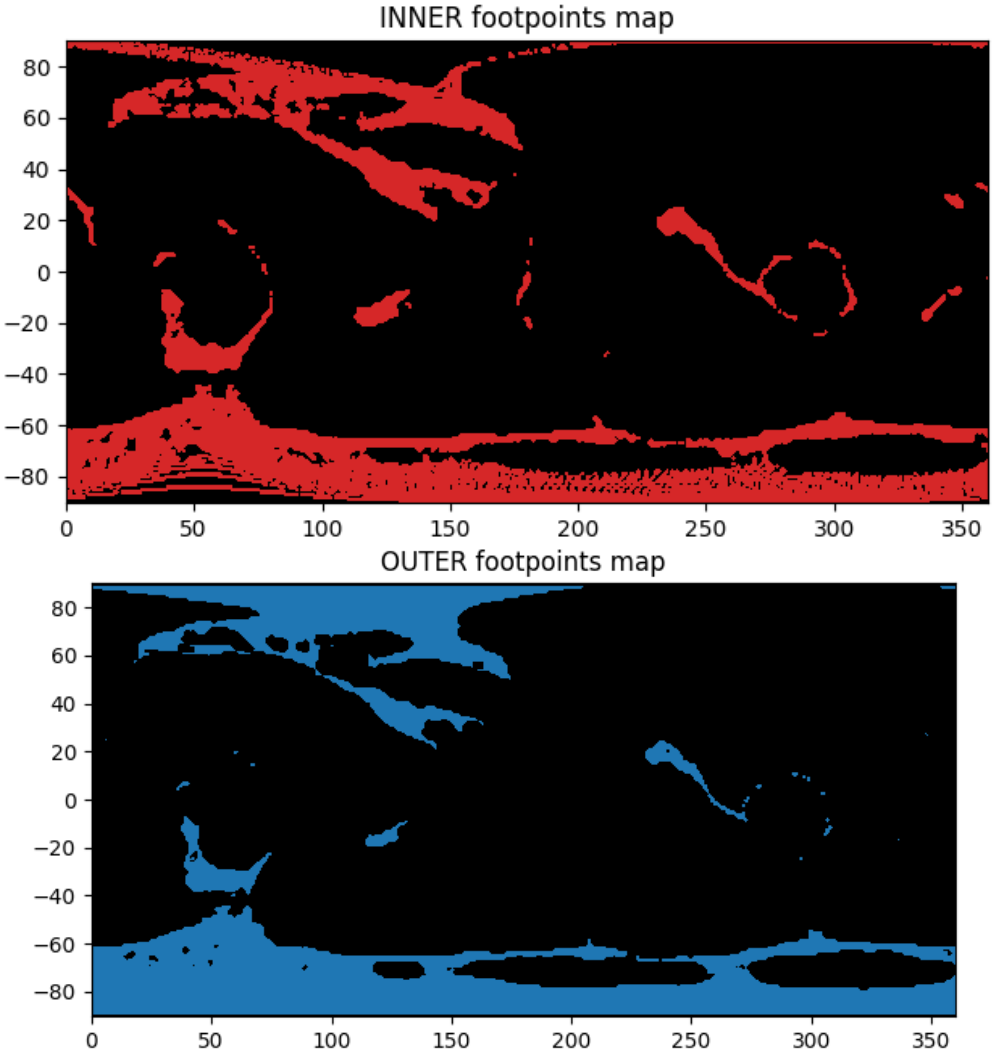

Fig. 2 - Open field on the photosphere obtained from GONG data .
Tracing magnetic field lines inward (top) and outward (bottom). There are slight discrepancies, indicating incomplete data from each individual measurement.

Figure 3 shows the results of a study of the behavior of the NMF during the year and a half of the maximum of the last solar cycle. The black line shows the NMF values obtained from direct observations, while the red and blue lines show the NMF change calculated by the PFSS model based on photospheric maps from the Kislovodsk Astronomical Station and GONG. There is a significant discrepancy between the observational data and the model calculations, characteristic of solar maximums. The data from the Kislovodsk Astronomical Station provide slightly better results than those from GONG.

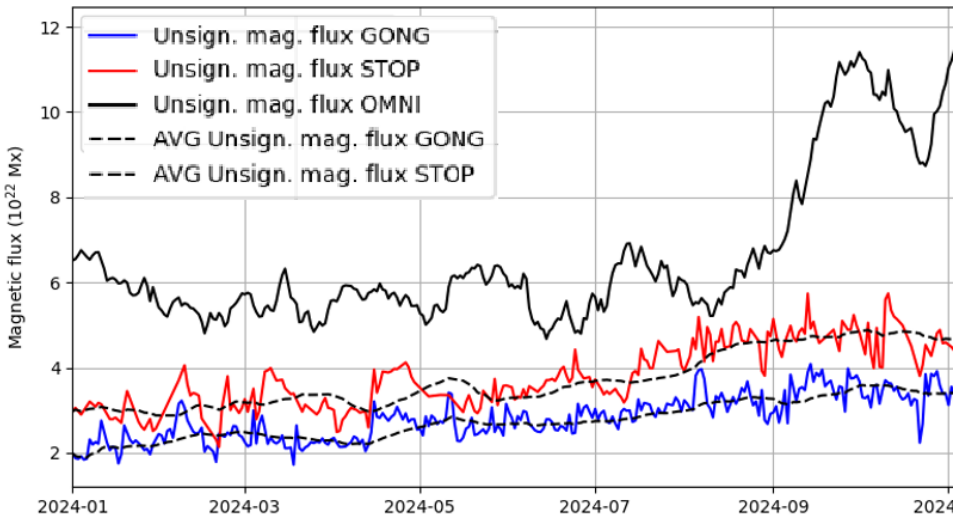

Fig. 3 - Change in the open magnetic flux during the last solar activity cycle according to OMNI data (direct observation), the STOP magnetograph (Kislovodsk Astronomical Station), and GONG. The vertical axis shows the OMF values obtained by direct observation or using the coronal field model.

Conclusion. The solar magnetic flux estimated using the PFSS model was studied using ground-based observations from the Kislovodsk Astronomical Station and GONG. The results show a significant discrepancy with direct spacecraft observations, typical during periods of solar maximum. Apparently, the accuracy of the potential model is insufficient to obtain an adequate coronal magnetic field that would fully account for the NMF. Conclusion: MHD models are necessary for constructing the coronal magnetic field used in solar wind modeling.

Список источников

1. Levine R.H. Open magnetic fields and the solar cycle. Solar Physics. 1982. Vol. 79. P. 203-230. https://doi.org/10.1007/BF00146241.
2. Altschuler M. D., Newkirk G. Magnetic fields and the structure of the solar corona. Solar Physics. 1969. Vol. 9. P. 131-149. https://doi.org/10.1007/BF00145734.
3. Schatten K.H. Current sheet magnetic model for the solar corona. Cosmic Electrodynamics. 1971. Vol. 2. P. 232-245.
4. Wang Y.M., Sheeley N.R.J. On potential field models of the solar corona. The Astrophysical Journal. 1992. Vol. 392. P. 310-319. https://doi.org/10.1086/171430.
5. Berezin I., Tlatov A. Coronal field geometry and solar wind speed**.** Universe. 2022. Vol. 8. № 12. P. 646. https://doi.org/10.3390/universe8120646
6. Demidov M.L., Hanaoka Y., Wang X.F., Kirichkov P.N. On the Differences in the Ambient Solar Wind Speed Forecasting Caused by Using Synoptic Maps from Different Observatories**.** Solar Physics. 2023. Vol. 298. 120. https://doi.org/10.1007/s11207-023-02206-6.
7. Wang Y.-M., Sheeley N.R.Jr. Coronal Plumes and Their Relationship to Network Activity. The Astrophysical Journal. 1995. Vol. 447. L143. https://doi.org/10.1086/176317
8. Wang Y.-M., Lean J., Sheeley N.R.Jr. The long-term variation of the Sun's open magnetic flux. Geophysics Research Letters. 2000. Vol. 27. No. 4. P. 505-508. https://doi.org/10.1029/1999GL010744.
9. Wallace S., Arge C.N., Pattichis M., *et al*. Estimating Total Open Heliospheric Magnetic Flux. Solar Physics. 2019. Vol. 294. 19. https://doi.org/10.1007/s11207-019-1402-1.

10. Wang Y.-M., Ulrich R.K., Harvey J.W. Magnetograph Saturation and the Open Flux Problem. The Astrophysical Journal. 2022. Vol. 926. No. 2. P. 113. https://doi.org/10.3847/1538-4357/ac4491.
11. Arge C.N., Leisner A., Antiochos S.K., Wallace S., Henney C.J. Proposed Resolution to the Solar Open Magnetic Flux Problem. The Astrophysical Journal. 2024. Vol. 964. No. 2. P. 115. https://doi.org/10.3847/1538-4357/ad20e2
12. Posner A., Arge C.N., Staub J., *et al*. A Multi-Purpose Heliophysics L4 Mission. Space Weather. 2021. Vol. 19. No. 9. https://doi.org/10.1029/2021SW002777.
13. Harvey J.W., Branston D., Henney C.J., *et. al*. Seething horizontal magnetic fields in the quiet solar photosphere. The Astrophysical Journal Letters. 2007. Vol. 659. No. 2. L177-L180. https://doi.org/10.1086/518036
14. Михаляев О.Н., Сапралиев М.Е., Манкаева Г. А. и др. Проект Sun Gazers. Современная наука и инновации. 2023. № 4 (44). С. 56-63. https://doi.org/10.37493/2307-910X.2023.4.6

References

1. Levine R.H. Open magnetic fields and the solar cycle. Solar Physics. 1982. Vol. 79. P. 203-230. https://doi.org/10.1007/BF00146241.
2. Altschuler M. D., Newkirk G. Magnetic fields and the structure of the solar corona. Solar Physics. 1969. Vol. 9. P. 131-149. https://doi.org/10.1007/BF00145734.
3. Schatten K.H. Current sheet magnetic model for the solar corona. Cosmic Electrodynamics. 1971. Vol. 2. P. 232-245.
4. Wang Y.M., Sheeley N.R.J. On potential field models of the solar corona. The Astrophysical Journal. 1992. Vol. 392. P. 310-319. https://doi.org/10.1086/171430.
5. Berezin I., Tlatov A. Coronal field geometry and solar wind speed. Universe. 2022. Vol. 8. № 12. P. 646. https://doi.org/10.3390/universe8120646
6. Demidov M.L., Hanaoka Y., Wang X.F., Kirichkov P.N. On the Differences in the Ambient Solar Wind Speed Forecasting Caused by Using Synoptic Maps from Different Observatories. Solar Physics. 2023. Vol. 298. 120. https://doi.org/10.1007/s11207-023-02206-6.
7. Wang Y.-M., Sheeley N.R.Jr. Coronal Plumes and Their Relationship to Network Activity. The Astrophysical Journal. 1995. Vol. 447. L143. https://doi.org/10.1086/176317
8. Wang Y.-M., Lean J., Sheeley N.R.Jr. The long-term variation of the Sun's open magnetic flux. Geophysics Research Letters. 2000. Vol. 27. No. 4. P. 505-508. https://doi.org/10.1029/1999GL010744.
9. Wallace S., Arge C.N., Pattichis M., et al. Estimating Total Open Heliospheric Magnetic Flux. Solar Physics. 2019. Vol. 294. 19. https://doi.org/10.1007/s11207-019-1402-1.
10. Wang Y.-M., Ulrich R.K., Harvey J.W. Magnetograph Saturation and the Open Flux Problem. The Astrophysical Journal. 2022. Vol. 926. No. 2. P. 113. https://doi.org/10.3847/1538-4357/ac4491.
11. Arge C.N., Leisner A., Antiochos S.K., Wallace S., Henney C.J. Proposed Resolution to the Solar Open Magnetic Flux Problem. The Astrophysical Journal. 2024. Vol. 964. No. 2. P. 115. https://doi.org/10.3847/1538-4357/ad20e2
12. Posner A., Arge C.N., Staub J., et al. A Multi-Purpose Heliophysics L4 Mission. Space Weather. 2021. Vol. 19. No. 9. https://doi.org/10.1029/2021SW002777.
13. Harvey J.W., Branston D., Henney C.J., et. al. Seething horizontal magnetic fields in the quiet solar photosphere. The Astrophysical Journal Letters. 2007. Vol. 659. No. 2. L177-L180. https://doi.org/10.1086/518036
14. Mikhalyaev O.N., Sapraliev M.E., Mankaeva G. A. i dr. Proekt Sun Gazers. Covremennaya nauka i innovatsii. 2023. № 4 (44). S. 56-63. https://doi.org/10.37493/2307-910X.2023.4.6

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Политический процесс в новых регионах России: теоретические и методологические подходы

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Аннотация. ***Введение.*** В статье рассматриваются теоретические и методологические основы анализа политического процесса в новых субъектах Российской Федерации – Донецкой и Луганской Народных Республиках, Запорожской и Херсонской областях. Актуальность исследования обусловлена уникальностью их интеграционного пути, сочетающего постконфликтную трансформацию, институциональное строительство и социокультурную адаптацию в правовом поле России. ***Цель.*** Систематизировать основные теоретические концепции и разработать комплексный методологический подход к изучению политического процесса в новых регионах России, выявив его специфические черты и этапы. ***Материалы и методы.*** Исследование построено на анализе научной литературы по политической регионалистике, транзитологии и теории интеграции. Используются методы институционального, сравнительно-политического и системного анализа, а также контент-анализ нормативно-правовых актов и публичных выступлений ключевых политических акторов. ***Результаты и обсуждение.*** Выделены ключевые этапы политического процесса: конфликтно-сепаратистский (до 2022 г.), легитимационно-интеграционный (2022-2023 гг.) и этап системной институционализации (с 2024 г.). Обоснована необходимость применения синтетической модели анализа, сочетающей инструментарий транзитологии (учет нелинейности и роли элит) и теорий политической интеграции (ассимиляция и аккомодация). Особое внимание уделено факторам, осложняющим процесс: последствия военных действий, необходимость формирования новой политической идентичности, интеграция местных элит в общероссийские политические практики. ***Заключение.*** Политический процесс в новых регионах носит гибридный, многоуровневый и нелинейный характер. Его эффективное изучение требует отказа от классических линейных моделей транзита в пользу комплексных подходов, учитывающих уникальный контекст постконфликтной интеграции, доминирующую роль федерального центра и динамику взаимодействия формальных институтов и неформальных практик. Перспективным направлением исследований является сравнительный анализ интеграционных траекторий новых субъектов РФ между собой и с другими постконфликтными регионами мира.

Ключевые слова: новые регионы России, политический процесс, Донбасс, интеграция, транзитология, институционализация, политическая идентичность, федерализм.

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Research article

The Political Process in the New Regions of Russia: Theoretical and Methodological Approaches

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Abstract. ***Introduction.*** The article examines the theoretical and methodological foundations for analyzing the political process in the new subjects of the Russian Federation – the Donetsk and Lugansk People's Republics, Zaporizhzhia and Kherson regions. The relevance of the study is due to the uniqueness of their integration path, combining post-conflict transformation, institutional building and socio-cultural adaptation within the legal framework of Russia. ***Goal.*** To systematize the main theoretical concepts and develop a comprehensive methodological approach to studying the political process in the new regions of Russia, identifying its specific features and stages. ***Materials and methods.*** The study is based on the analysis of scientific literature on political regionalism, transitology and integration theory. Methods of institutional, comparative-political and systemic analysis are used, as well as content analysis of regulatory legal acts and public speeches of key political actors.
Results and discussion. The key stages of the political process are identified: the conflict-separatist stage (until 2022), the legitimation-integration stage (2022-2023) and the stage of systemic institutionalization (from 2024). The necessity of applying a synthetic model of analysis combining the tools of transitology (accounting for non-linearity and the role of elites) and theories of political integration (assimilation and accommodation) is substantiated. Special attention is paid to complicating factors: the consequences of hostilities, the need to form a new political identity, the integration of local elites into all-Russian political practices. ***Conclusion.*** The political process in the new regions is hybrid, multi-level and non-linear. Its effective study requires a rejection of classical linear transit models in favor of comprehensive approaches that take into account the unique context of post-conflict integration, the dominant role of the federal center and the dynamics of interaction between formal institutions and informal practices. A promising area of research is a comparative analysis of the integration trajectories of the new subjects of the Russian Federation among themselves and with other post-conflict regions of the world.
Key words: new regions of Russia, political process, Donbas, integration, transitology, institutionalization, political identity, federalism.
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Introduction. The incorporation of the Donetsk and Luhansk People's Republics, and the Zaporizhia and Kherson Oblasts into the Russian Federation represents an unprecedented case of large-scale political border changes and a complex, multi-layered integration process in modern

history. The political process in these new constituent entities of the Russian Federation is unfolding under a unique combination of factors: an unfinished armed conflict, profound socioeconomic transformation, active institution-building, and the formation of a new civic and political identity. Traditional theories of democratic transition or classical models of federalism prove insufficient for an adequate analysis. Therefore, there is a pressing need for theoretical understanding and the development of specific methodological tools that account for the hybrid, nonlinear, and contextual nature of this process.

Materials and methods of research. The methodological basis of the study is a synthesis of several theoretical approaches. Firstly, this is the toolkit **of political transitology**, revised taking into account the criticism of linear models and adapted to the conditions of "directed transit" under the auspices of the federal center. Secondly, approaches **of political regionalism are applied**, focusing on the interaction between the center and the periphery, the asymmetry of regional development and the specifics of regional political regimes. Thirdly, theories **of political integration are used** (in particular, the models of assimilation and accommodation), allowing for the analysis of the process of incorporation of new territories and populations into a single legal, economic and symbolic space of the state [1]. The empirical base consists of the Constitution of the Russian Federation, federal constitutional laws on the admission of new subjects, charters and legislation of new regions, programmatic documents of leading political parties, as well as data from sociological research conducted in these territories. The main methods are institutional and comparative analysis, discourse analysis of the public field, and expert assessments.

Research results and discussion. The analysis revealed three conditional, partially overlapping, stages of the political process in the new regions:

1. **Conflict-separatist (until 2022):** Characterized by the formation of political institutions in the Donbas republics amidst war, the emergence of their own elite groups, and the search for external legitimacy. The political process was subordinated to the logic of survival and military confrontation.
2. **Legitimation and Integration (2022-2023):** The key event was formal legal integration through referendums and the adoption of constitutional laws. This stage was dominated by the implementation of federal legislation, the creation of basic governing institutions in the constituent entities of the Russian Federation, and the launch of socio-economic support programs. The political process is strictly centralized and controlled from Moscow.
3. **The stage of systemic institutionalization (from 2024):** The tasks of forming a stable and self-reproducing political system integrated into the all-Russian one come to the fore. This includes: a) adaptation of the all-Russian party system (integration of United Russia and systemic parties into the local political landscape); b) integration of regional elites into federal networks of influence and lobbying practices; c) formation of a new political identity combining local “Donbass” or “Black Sea” specifics with the all-Russian civic consciousness [2] .

The main methodological challenge is the hybridity of emerging institutions, in which formal rules imported from the federal center are closely intertwined with informal practices rooted in the specific social capital of post-Soviet Donbas and southern Ukraine [3]. This creates the risk of "institutional gaps" and requires researchers to focus on everyday governance practices, not just regulatory acts.

Conclusion. Thus, the political process in Russia's new regions represents a unique laboratory for post-conflict state-building and political integration. Its theoretical understanding requires a rejection of orthodox models in favor of a comprehensive, interdisciplinary approach. The synthetic model developed in this article, combining adapted tools from transitology, regional studies, and integration theory, allows us to identify key drivers and barriers to the process. Further research should focus on a comparative analysis of internal dynamics in various new regions, an examination of local elite adaptation mechanisms, and an analysis of the

population's perception of integration processes, which is a determining factor in the long-term sustainability of the new political reality.

Список источников

1. Туровский Р. Ф. Политическая регионалистика: учебник для вузов. М.: Изд-во «ГУ-ВШЭ», 2006. 780 с.
2. Gel'man V., Ryzhenkov S. Political Elites in Russia's Regions: Evolution of Recruitment Patterns and Interaction Networks. *Europe-Asia Studies*. 2021;73(5): 793-815. https://doi.org/10.1080/09668136.2021.1938050
3. Харитонова О. Г. Гибридные политические режимы: генезис, институты, динамика. М.: РОССПЭН, 2017. 303 с.
4. Казанцев А. А., Федоров В. В. Интеграция новых территорий в политическую систему России: институциональный аспект // Полис. Политические исследования. 2023. № 5. С. 25–42. https://doi.org/10.17976/jpps/2023.05.03
5. Сатаров Г. А. Трансформация политического режима в России: от эволюции к революции? // Общественные науки и современность. 2022. № 4. С. 38-55.
6. Matsuzato K. (ed.) Emerging Federal Structures in the Post-Cold War Era. Palgrave Macmillan, 2022. 410 p.
7. Официальный сайт Центральной избирательной комиссии Российской Федерации. Раздел «Выборы в субъектах РФ». URL: http://www.cikrf.ru/ (дата обращения: 20.02.2025).
8. Законодательное собрание Луганской Народной Республики. Официальный портал. URL: http://sovetlnr.ru/ (дата обращения: 20.02.2025).
9. Дробижева Л. М. Российская идентичность: дискуссии в политическом пространстве и динамика массового сознания. М.: ИС РАН, 2020. 280 с.
10. Колосов В. А., Зотова М. В. Новые границы России: геополитическое и геоэкономическое измерение // Контуры глобальных трансформаций: политика, экономика, право. 2024. Т. 17. № 1. С. 176-199.

References

1. Turovskii RF. Politicheskaya regionalistika: uchebnik dlya vuzov [Political Regionalistics: A Textbook for Universities]. Moscow: HSE Publishing House; 2006. 780 p. (In Russ.).
2. Gel'man V, Ryzhenkov S. Political Elites in Russia's Regions: Evolution of Recruitment Patterns and Interaction Networks. *Europe-Asia Studies*. 2021;73(5):793-815. https://doi.org/10.1080/09668136.2021.1938050
3. Kharitonova OG. Gibridnye politicheskie rezhimy: genezis, instituty, dinamika [Hybrid Political Regimes: Genesis, Institutions, Dynamics]. Moscow: ROSSPEN; 2017. 303 p. (In Russ.).
4. Kazantsev AA, Fedorov VV. Integratsiya novykh territorii v politicheskuyu sistemu Rossii: institutsional'nyy aspekt [Integration of New Territories into the Political System of Russia: Institutional Aspect]. *Polis. Politicheskie issledovaniya* = Polis. Political Studies. 2023;(5):25-42. (In Russ.). https://doi.org/10.17976/jpps/2023.05.03
5. Satarov GA. Transformatsiya politicheskogo rezhima v Rossii: ot evolyutsii k revolyutsii? [Transformation of the Political Regime in Russia: from Evolution to Revolution?]. *Obshchestvennye nauki i sovremennost'* = Social Sciences and Contemporary World. 2022;(4):38-55. (In Russ.).
6. Matsuzato K. (ed.) Emerging Federal Structures in the Post-Cold War Era. Palgrave Macmillan; 2022. 410 p.
7. Tsentral'naya izbiratel'naya komissiya Rossiyskoy Federatsii. Razdel «Vybory v sub"ektakh RF» [Central Election Commission of the Russian Federation. Section "Elections in the Subjects of the RF"]. Available from: http://www.cikrf.ru/ [Accessed 20 Feb 2025]. (In Russ.).
8. Zakonodatel'noe sobranie Luganskoy Narodnoy Respubliki. Ofitsial'nyy portal [Legislative Assembly of the Lugansk People's Republic. Official portal]. Available from: http://sovetlnr.ru/ [Accessed 20 Feb 2025]. (In Russ.).
9. Drobizheva LM. Rossiyskaya identichnost': diskussii v politicheskom prostranstve i dinamika massovogo soznaniya [Russian Identity: Debates in the Political Space and Dynamics of Mass Consciousness]. Moscow: Institute of Sociology RAS; 2020. 280 p. (In Russ.).

10. Kolosov VA, Zotova MV. Novye granitsy Rossii: geopoliticheskoe i geoekonomicheskoe izmerenie [New Borders of Russia: Geopolitical and Geo-Economic Dimension]. *Kontury global'nykh transformatsiy: politika, ekonomika, pravo* = Outlines of global transformations: politics, economics, law. 2024;17(1):176-199. (In Russ.).

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Conceptualization and research design — development of the general idea, goals and methodology of the study.

Writing (original draft preparation) — writing the main part of the manuscript.

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Формирование новых политических элит в условиях специальной военной операции

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Аннотация. ***Введение.*** Специальная военная операция (СВО), начатая в 2024 году, стала не только военно-политическим, но и глубоким социально-политическим рубежом для российской государственности. Она активизировала процессы трансформации властных структур и кадрового обновления на различных уровнях управления. ***Цель***. Целью исследования является выявление и анализ механизмов, каналов и критериев формирования новых групп политической элиты в России в условиях СВО, а также оценка их влияния на политическую систему. ***Материалы и методы.*** Исследование построено на анализе широкого массива открытых источников, включая базы биографических данных, официальные документы, медиатексты и материалы социальных сетей за период 2022–2024 гг. Методологическая рамка является междисциплинарной и основана на синтезе качественных подходов: институционального анализа для изучения изменений в правилах и процедурах отбора; биографического (просопографического) анализа для реконструкции коллективных портретов и карьерных траекторий «новых» назначенцев; критического дискурс-анализа публичных высказываний и медианарративов для выявления легитимирующих критериев; сравнительного кейс-стади для углубленного изучения специфики регионального и отраслевого рекрутирования. ***Результаты и обсуждение.*** В ходе работы обнаружено, что ключевым трендом является формирование новой иерархии, в которой доминирующие позиции занимают носители компетенций, критически важных для ведения конфликта и обеспечения национальной безопасности в широком смысле. Это привело к эффекту «силового дрейфа» — экспансии выходцев из военных, спецслужб и правоохранительных органов в гражданские сферы управления, экономики и дипломатии. Параллельно произошло становление класса «технократов-мобилизационщиков» в оборонно-промышленном комплексе и логистике, чья эффективность измеряется конкретными, измеримыми результатами в условиях санкций. Важнейшим социальным изобретением стала ускоренная институционализация новой медиа- и идеологической элиты (военкоры, патриотические блогеры, ведущие пропагандистских шоу), выполняющей функции смыслополагания, мобилизации и прямой коммуникации. Система критериев отбора качественно изменилась: лояльность эволюционировала в сторону активной публичной идеологической ангажированности; эффективность переопределена как способность достигать целей в экстремальных условиях «фронта» и «тыла», часто в обход процедур; публичная перформативность поддержки курса стала обязательным условием легитимности. ***Заключение.*** По итогам проведенного исследования можно сделать вывод о том, что специальная военная операция выступила катализатором глубинной и, вероятно, необратимой трансформации элитной структуры. Вместо ситуативных кадровых перестановок сформировался устойчивый контур новой правящей группы, ядро которой основано на синтезе силового капитала, мобилизационной результативности и идеологической идентичности. Это ведет к артикуляции и закреплению новой социальной нормы в элитном сознании, для которой характерны этатизм, централизация, конфронтационное мышление и примат безопасности над другими общественными целями.

Долгосрочными последствиями станут усиление авторитарных тенденций, перераспределение ресурсов и влияния в пользу силового и оборонно-промышленного блоков, а также формирование специфической модели посткризисного управления, унаследовавшей от военного времени логику чрезвычайщины, иерархии и перманентной мобилизации.
Ключевые слова: политическая элита, специальная военная операция (СВО), рекрутирование элит, мобилизационная эффективность, силовой блок, технократы-мобилизационщики, медиаэлита, публичный дискурс, этатизм, трансформация политической системы.
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Research article

Formation of new political elites in the context of a special military operation

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Abstract. ***Introduction.*** The Special Military Operation (SVO), launched in 2024, has become not only a military-political, but also a deep socio-political frontier for Russian statehood. She has intensified the processes of transformation of power structures and personnel renewal at various levels of government. ***Goal.*** The purpose of the study is to identify and analyze the mechanisms, channels and criteria for the formation of new groups of the political elite in Russia in the conditions of the SVR, as well as to assess their impact on the political system. ***Materials and methods.*** The study is based on an analysis of a wide range of open sources, including biographical databases, official documents, media texts, and social media materials for the period 2022-2024. The methodological framework is interdisciplinary and based on a synthesis of qualitative approaches: institutional analysis to study changes in selection rules and procedures; biographical (prosopographic) analysis to reconstruct collective portraits and career trajectories of "new" appointees.; a critical discourse analysis of public statements and media narratives to identify legitimizing criteria; a comparative case study for an in-depth study of the specifics of regional and sectoral recruitment. ***Results and discussion.*** In the course of the work, it was found that the key trend is the formation of a new hierarchy, in which the dominant positions are occupied by holders of competencies that are critically important for conflict management and ensuring national security in a broad sense. This led to the effect of "force drift" — the expansion of immigrants from the military, special services and law enforcement agencies into civilian spheres of government, economics and diplomacy. In parallel, a class of "mobilization technocrats" has emerged in the military-industrial complex and logistics, whose effectiveness is measured by concrete, measurable results in the face of sanctions. The most important social invention was the accelerated institutionalization of a new media and ideological elite (military officers, patriotic bloggers, and hosts of propaganda shows), which performs the functions of meaning-making, mobilization, and direct communication. The system of selection criteria has changed qualitatively: loyalty has evolved towards active public ideological engagement; effectiveness has been redefined as the ability to achieve goals in extreme conditions of the "front" and "rear", often bypassing procedures; public performativity of course support has become a prerequisite for legitimacy. ***Conclusion.*** Based on the results of the study, it can be concluded that the

special military operation acted as a catalyst for a profound and probably irreversible transformation of the elite structure. Instead of situational personnel changes, a stable outline of a new ruling group has been formed, the core of which is based on a synthesis of power capital, mobilization effectiveness and ideological identity. This leads to the articulation and consolidation of a new social norm in the elite consciousness, which is characterized by statism, centralization, confrontational thinking and the primacy of security over other social goals. The long-term consequences will be the strengthening of authoritarian tendencies, the redistribution of resources and influence in favor of the military and military-industrial blocs, as well as the formation of a specific model of post-crisis management, inherited from wartime logic of emergency, hierarchy and permanent mobilization.
Keywords: political elite, special military operation (SVO), elite recruitment, mobilization efficiency, power bloc, mobilization technocrats, media elite, public discourse, statism, transformation of the political system.
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Introduction. The contemporary Russian political system is undergoing a profound internal transformation, driven by both global challenges (changing world order, sanctions pressure) and the need to consolidate society and elites in the context of a special military operation (SMO). SMOs act not only as a military-political event but also as a powerful institutional and social catalyst, reformatting the logic of governance, personnel policy, and elite formation. Under these conditions, the ruling class is undergoing active renewal and rotation, new figures are emerging, and recruitment channels and selection criteria are evolving differently than in previous decades.

The relevance of this study stems from the need to understand these rapid changes in the structure and composition of the Russian elite. Traditional classical elite theories (G. Mosca, V. Pareto, R. Mills), which describe elite circulation and the "ruling class," as well as contemporary Russian studies (O. V. Kryshtanovskaya, V. P. Mokhov, L. V. Smorgunov), which focused on the analysis of post-Soviet transformation, business elites, and the "power" component, require significant expansion in the new context. O. V. Gaman-Golutvina's work on the types and transformations of elites in Russia has created a solid foundation; however, the period after 2022 is characterized by qualitative acceleration and new priorities that have not yet received a comprehensive scholarly understanding.

The aim of the study is to identify and analyze the main channels, criteria and trajectories of the formation of a new managerial and political elite in Russia in the context of the SVO and the associated mobilization.

Research objectives:

1. To analyze institutional changes in key channels of elite recruitment (the Presidential Administration, the United Russia party, the institution of governorship).
2. To explore the career patterns and spheres of influence of those promoted from the "power" bloc.
3. Characterize the role of managers of the mobilization economy and frontline regions.
4. To define the functions and status of new ideologists and the “media elite” in the context of the SVO.

5. Formulate new dominant criteria for selecting elites and compare them with pre-crisis ones.

The research hypothesis is that the SVO did not lead to a situational personnel reshuffle, but to the formation of a stable new elite group, the core of which is formed on the basis of a synthesis of loyalty, practical effectiveness in times of crisis, and public identity associated with support for the official course, which leads to the strengthening of the statist and mobilizational features of the political system in the long term.

Research materials and methods. The research methodological framework is interdisciplinary, combining political science, sociology, and institutional approaches.

1. **The institutional approach** is used to analyze changes in formal and informal recruitment rules in key political institutions. It allows us to assess how the Presidential Administration, the United Russia party, and the executive branch are adapting their procedures to new challenges.

2. **Sociological (biographical and event-based) analysis** is used to study the career trajectories of new elite figures. Publicly available biographical data (age, education, previous positions, regional and industry affiliations) of those appointed to key positions in the period 2022-2024 is collected and analyzed. This allows us to identify typical career growth patterns.

3. **Content analysis of media and public discourse.** Official statements, public speeches, interviews with key figures, as well as materials from state and pro-Kremlin media outlets are examined. The goal is to identify the established criteria for evaluating personnel ("effectiveness," "patriotism," "resilience"), key narratives, and symbols that construct the legitimacy of the new elite.

4. **Case study (comparative case study).** Specific cases are selected for in-depth analysis:

- Appointments of governors in frontline and border regions (for example, Belgorod and Kursk regions).
- Appointments of heads of defense-industrial corporations and logistics hubs.
- Institutionalization of individual media figures (war correspondents, bloggers) and their integration into official structures.

The source base consists of open data: official websites of government agencies and companies, biographical databases, news agency archives (TASS, RIA Novosti, Interfax), materials from specialized media and Telegram channels.

Research results and discussion. The implementation of the SVO led to a reformatting of traditional channels. The Presidential Administration's personnel work shifted its focus from balancing clan groups to finding and promoting "mobilization managers" with proven ability to solve problems in crisis situations. The United Russia party strengthened its role as a talent pool and a tool for upward mobility for regional and local activists who had distinguished themselves in supporting the SVO (humanitarian headquarters, patriotic projects). The institution of governorship underwent significant rotation, especially in the regions most affected by the war, where skills in rapid logistics, security, and coordination with law enforcement agencies, rather than solely socioeconomic development, became more important.

There has been a significant increase in the influence and expanded responsibilities of those from the security agencies (the Ministry of Defense, the FSB, the National Guard, and the Ministry of Emergency Situations). Their career patterns demonstrate a shift from operational and command positions to positions in the civil administration (vice governors for security, regional leaders), corporate governance (especially in strategic sectors), and diplomatic work. This indicates the emergence of a management culture that prioritizes discipline, hierarchy, secrecy, and the ability to operate under conditions of uncertainty and direct opposition.

Those responsible for ensuring the functioning of the economy under sanctions and the strain of mobilization have dramatically increased their status. The heads of major defense enterprises and holdings (Rostec, UAC) have become key political actors. The role of managers in logistics, import substitution, and energy has increased. Governors of industrial regions (the

Urals, Siberia) tied to the military-industrial complex have received additional resources and political clout. Their effectiveness is assessed through specific, measurable delivery indicators, creating a new type of "mobilization technocrat."

The SVO has given rise to a new layer of public ideologists and media figures who interpret events, mobilize public opinion, and legitimize government actions. Political strategists, propaganda talk show hosts, war correspondents, and patriotic bloggers with millions of followers have acquired a quasi-official status. Many of them receive state awards, official positions in public chambers or advisory bodies, and are becoming institutionalized. They shape public discourse and themselves become a new channel for feedback and even recruitment (for example, recommendations from war correspondents).

There has been a shift in the system of criteria. While in the 2000s and 2010s, a combination of **loyalty** and **technocratic efficiency** (often in a narrow sphere), as well as informal **clannishness** , dominated, now:

- **Loyalty** is understood as not just personal devotion, but active, public defense of the official course and its ideological foundations.
- **Efficiency** takes on **a "mobilization"** character – it is the ability to achieve results "at any cost," in a short time, under constraints and external pressure, often with the use of force and the simplification of procedures.
- **Publicity** is becoming a requirement. The new elite must be able to publicly articulate their position within the established narrative, demonstrate personal involvement (visiting the SVO zone, meeting with military personnel), and be part of the overall media landscape.

Conclusion. The study concludes that the SVO is a powerful factor in the transformation of the Russian elite structure. It confirms the main hypothesis that the ongoing changes are not situational but systemic in nature and lead to the formation of a new, sustainable elite group.

1. **By section:** The transformation affected all key recruiting institutions, shifting the emphasis to mobilization effectiveness. The "power bloc" and military-industrial complex managers significantly strengthened their positions, forming a new elite core. Ideologists and the media elite underwent accelerated institutionalization. Selection criteria evolved toward the triad of "loyalty, mobilization effectiveness, and publicity."
2. **On the status of the group:** The emerging group possesses the characteristics of a new elite, rather than a temporary pool: it controls key resources (power, economic, informational), possesses unique legitimizing capital (merits in the face of a "historical challenge"), and demonstrates the ability to self-reproduce through new institutional channels.
3. **Long-term consequences for the political system:**
   - **Strengthening of statism and centralization:** The primacy of state interests in their forceful interpretation becomes absolute.
   - **"Militarization of consciousness" of the elite:** Crisis, confrontational thinking, experience of working in the logic of "front and rear" are consolidated as the norm.
   - **Shifting balance of influence:** There is a relative weakening of the positions of traditional "liberal" technocrats and financial-economic blocs, while the security forces, military-industrial complex industrialists, and ideologists are simultaneously strengthening.
   - **Formation of a new social ladder:** Public support for the SVO and practical work in its interests are becoming the main social elevator.

Future research areas include: studying intra-elite dynamics and potential conflicts between "new" and "old" groups; analyzing the social origins and values of the new elite; comparative analysis of elite transformation in Russia and other countries experiencing periods of mobilization; and investigating the long-term impact of this transformation on the country's economic model and foreign policy.

Список источников

1. Гаман-Голутвина О.В. Политические элиты России: Вехи исторической эволюции. – М.: РОССПЭН, 2006. 446с.
2. Крыштановская О.В. Анатомия российской элиты. М.: Захаров, 2005. 384с.
3. Моска Г. Правящий класс / Пер. с англ. и примеч. Т. Н. Самсоновой // Социологические исследования. - 1994. № 10. № 12. С. 97-117.
4. Парето В. Компендиум по общей социологии. М.: Изд. дом ВШЭ, 2008.
5. Mills C.W. The Power Elite. New York: Oxford University Press, 1956.
6. Мохов В.П. Эволюция региональной политической элиты России (1950-2010 гг.). – Пермь: Изд-во ПГТУ, 2011.
7. Сморгунов Л.В. Сравнительная политология: Учебник для вузов. – М.: Аспект Пресс, 2022.
8. Ротарь И.Г. Силовики в политике: особенности российской модели // Политические исследования (Полис). 2021. № 2.
9. Zavadskaya M., Baev P. (Eds.) Russia’s Elites in the Wake of the Ukraine War: Reshuffle, Loyalty, and Opposition. – FIIA Report, 2023.
10. Быкова А.С., Петухов В.В. Новые медиа как канал рекрутирования публично-политической элиты в России (на примере деятельности военных корреспондентов) // Вестник РГГУ. Серия «Политология. История. Международные отношения». 2023. № 4.

References

1. Gaman-Golutvina O.V. Politicheskie ehlity Rossii: Vekhi istoricheskoi ehvolyutsii. – M.: ROSSPEHN, 2006. 446s.
2. Kryshtanovskaya O.V. Anatomiya rossiiskoi ehlity. – M.: Zakharov, 2005. 384s.
3. Moska G. Pravyashchii klass // Sotsiologicheskie issledovaniya. 1994. № 10. № 12. C. 97-117.
4. Pareto V. Kompendium po obshchei sotsiologii. – M.: Izd. dom VSHEH, 2008.
5. Mills C.W. The Power Elite. New York: Oxford University Press, 1956.
6. Mokhov V.P. Ehvolyutsiya regional'noi politicheskoi ehlity Rossii (1950-2010 gg.). – Perm': Izd-vo PGTU, 2011.
7. Smorgunov L.V. Sravnitel'naya politologiya: Uchebnik dlya vuzov. – M.: Aspekt Press, 2022.
8. Rotar' I.G. Siloviki v politike: osobennosti rossiiskoi modeli // Politicheskie issledovaniya (Polis). 2021. № 2.
9. Zavadskaya M., Baev P. (Eds.) Russia’s Elites in the Wake of the Ukraine War: Reshuffle, Loyalty, and Opposition. – FIIA Report, 2023.
10. Bykova A.S., Petukhov V.V. Novye media kak kanal rekrutirovaniya publichno-politicheskoi ehlity v Rossii (na primere deyatel'nosti voennykh korrespondentov) // Vestnik RGGU. Seriya «Politologiya. Istoriya. Mezhdunarodnye otnosheniYA». 2023. № 4.

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Сбор и анализ данных -- поиск, систематизация и интерпретация эмпирического материала.
Написание текста -- подготовка оригинального черновика и окончательной редакции рукописи.

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Conceptualization and formulation of research is the development of a common idea, goals and objectives of the work.
Data collection and analysis is the search, systematization and interpretation of empirical material.
Writing the text is the preparation of the original draft and the final revision of the manuscript.

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Историко-политологический анализ становления чеченской диаспоры в странах Ближнего Востока

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Аннотация. ***Введение.*** Переселение народов и закрепление их на новой территории представляет собой длительный исторический процесс, сопряженный со множеством факторов политического, социально-экономического, конфликтогенного характера. Со временем сменившие место проживания этнические группы способны сформировать полноценные диаспоры, которые обретают черты актора политического процесса. ***Материалы и методы.*** В этом контексте значительный исследовательский интерес представляет феномен мухаджирства народов Северного Кавказа, которые, пережив несколько волн переселения в Османскую империю, в настоящее время расселены в различных странах Ближнего Востока. Мухаджирство затронуло черкесов, ногайцев, народы Дагестана и т.д. Также сменить территорию своего проживания были вынуждены чеченцы, сыгравшие определенную роль в политическом развитии современного ближневосточного региона. На текущей момент представители чеченского народа преимущественно расселены в Ираке, Иордании, Сирии и Турции. Однако в каждом из указанных государств их диаспоральный статус и возможности участие в политическом процессе разнятся. Связано это в первую очередь с тем, что все перечисленные страны обладают собственной спецификой государственного устройства, а также сталкиваются с многочисленными конфликтами межконфессионального и межнационального уровня. Соответственно, возникает научно-практическая необходимость исследования историко-политологического контекста становления чеченской диаспоры в странах Ближнего Востока с целью углубления понимания особенностей политического процесса в регионе и влияния на него диаспор. ***Результаты и обсуждение.*** В статье проводится краткий исторический анализ появления чеченской диаспоры в ближневосточных государствах с учетом особенностей их политической жизни. Особое внимание уделяется той роли, которую играли выходцы из Чечни в развитии стран Ближнего Востока в период после распада Османской империи, а также в постколониальный период. **Заключение.** На основе указанного исследовательского подхода выявляются действующие характеристики чеченской диаспоры в странах региона.

Ключевые слова: Ближний Восток, политический процесс, диаспора, чеченская диаспора, мухаджирство, диаспоральная политика

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Research article

A historical and political analysis of the development of the Chechen diaspora in the Middle East

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Abstract. ***Introduction.*** The resettlement of peoples and their establishment in a new territory is a long-term historical process that is influenced by a variety of political, socio-economic, and conflict-related factors. Over time, ethnic groups that have relocated can form full-fledged diasporas that become active participants in the political process. ***Materials and methods.*** In this context, the phenomenon of the Muhajirs of the North Caucasus, who, having experienced several waves of migration to the Ottoman Empire, are currently settled in various countries of the Middle East, is of significant research interest. The Muhajirs include the Circassians, the Nogais, the peoples of Dagestan, and others. The Chechens, who played a role in the political development of the modern Middle East, were also forced to relocate. Currently, the Chechen people are predominantly settled in Iraq, Jordan, Syria, and Turkey. However, their diaspora status and opportunities for participation in the political process vary in each of these countries. ***Results and discussion.*** Equations are obtained for determining the values of the established amplitudes of oscillations. The influence of dispersion caused by the non-coincidence of temperatures and velocities of gas-suspension phases on the nonlinear interaction of standing waves is investigated. This is primarily due to the fact that all of these countries have their own specific features of government, as well as face numerous conflicts at the interfaith and interethnic levels. Consequently, there is a scientific and practical need to study the historical and political context of the formation of the Chechen diaspora in the Middle East in order to gain a deeper understanding of the political process in the region and the influence of the diasporas on it. The article provides a brief historical analysis of the emergence of the Chechen diaspora in Middle Eastern countries, taking into account the specific features of their political life. Special attention is given to the role played by Chechens in the development of Middle Eastern countries after the collapse of the Ottoman Empire, as well as during the post-colonial period.***Conclusion.*** Based on this research approach, the current characteristics of the Chechen diaspora in the countries of the region are identified..

Key words: Middle East, political process, diaspora, Chechen diaspora, muhajirs, diaspora politics.
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Introduction. The concept of "muhajirism," known as the mass migration of Muslim peoples to Muslim countries from countries where Muslims are a religious minority, also affected a portion of the population of the North Caucasus, who were forced to leave their places of residence and move to what is now the Middle East. Among these migrants were representatives of the Chechen people, who eventually formed diasporas in Iraq, Jordan, Syria,

and Turkey. The degree of involvement of the Chechen diaspora in the political process varies from country to country and is based on the specific developmental characteristics of each of these countries. Consequently, a historical and political analysis of the development of the Chechen diaspora in the Middle East contributes both to expanding knowledge of the specifics of the political process in the region and to identifying the characteristics of its activities in foreign countries.

Research Materials and Methods. The stated research problem primarily requires a synthesis of historical and political science approaches to identify the specific aspects of the Chechen diaspora's integration into the political life of Middle Eastern countries. Additionally, a comparative historical method was employed to compare the experience of the Chechen diaspora with that of other North Caucasian diasporas (such as the Circassian diaspora) in Middle Eastern countries to identify common patterns and unique characteristics. The research materials draw on a broad body of work related to the factual basis for the development and establishment of the Chechen diaspora in Middle Eastern countries.

Results of the study and their discussion. The emergence of the Chechen diaspora in the countries of the Middle East is associated with several waves of forced migration of various peoples of the North Caucasus to the territory of the Ottoman Empire. Taking into account the existing research on this period, we believe that they can be grouped as follows: early migrations (before 1858) - isolated, not mass cases, often under the guise of pilgrimage (Hajj); the peak of muhajirism (1858-1865) - the most large-scale migration, which was stimulated by the end of the Caucasian War and the policies of the Russian authorities; late migrations (1865 - 1914) - migrations of varying intensity, up until the First World War [10, 226]. According to estimates, during this time, about one million people could have migrated to the territory of the Middle East, among whom the predominant ones were Chechens, Circassians, Abkhazians, Nogais, various ethnic groups from Dagestan, etc. [5].

The Middle Eastern diasporas of the North Caucasian peoples underwent a long period of development. A.Kh. Israilov points out that two stages can be distinguished in the formation of the "muhajir" diasporas, including Chechens, in the region. The early stage is characterized by the initial consolidation in new territories, while the second stage is associated with the integration of people from the North Caucasus into Ottoman society, especially in the military and political/diplomatic spheres [8, 369]. The incorporation of Caucasian settlers into the Ottoman elite was part of a targeted state policy. In particular, the Porte's leadership addressed the tasks of military-strategic strengthening of the empire's internal provinces (Turkey), the development and control of empty and border lands, and strengthening its presence in the Arab provinces (Levant, Iraq) [2, 76]. Accordingly, military activity contributed to the strengthening of the "muhajir" position in the socio-political hierarchy of the Ottoman Empire.

Regarding the Chechen diaspora itself, it should be noted that people from Chechnya settled primarily in what is now Jordan, Iraq, Syria, and Turkey. These countries are currently the main destinations for Chechens in the Middle East. Separate Chechen diasporas in these countries began to develop after the collapse of the Ottoman Empire. The very disappearance of the Ottoman state led to a certain crisis for the Caucasian diasporas, as the region's political map was completely reshaped and a single center for the diasporas to focus on disappeared. The Ottoman Empire disintegrated into several Middle Eastern states, each of which began to develop its own elites.

After the formation of the Turkish state in 1923, many diasporas, including the Chechen one, faced threats to preserving their identity. An ideological shift occurred, with the new government rejecting Ottoman diversity in favor of Turkish nationalism and secularism. All non-Turkish minorities, especially Muslim ones, became the target of a strict assimilation policy. Examples of such policies include the "Surname Law" (1934), which prohibited the use of non-Turkish surnames and names of settlements; the "Resettlement Law" (1934), aimed at "Turkifying" regions (Chechen and other Caucasian villages were deliberately dispersed,

prohibited from living in compact settlements, and resettled in Turkish-speaking areas in order to dilute them and accelerate assimilation); The "Citizen, speak Turkish!" policy, which involved harsh pressure to abandon native languages (the Chechen language was forced out of the public sphere and education) [7, 79]. At the same time, the Chechens were gradually able to adapt to the new realities. This was facilitated by the so-called liberalization period that began in the 1950s. This stage in Turkish history allowed Chechens to move en masse to large cities (Istanbul, Ankara, Izmir, Bursa). In the cities, they had the opportunity to create communities and associations. Cultural societies and clubs began to appear, which, although not strictly Chechen, made it possible to preserve the language, dances and traditions. Representatives of the Chechen diaspora became prominent figures in the socio-political life of the country. For example, D. Guresh (former Chief of the General Staff of Turkey), General S. Polatkan, politician and journalist B. Yasar, etc. [7, 79]. Currently, according to various estimates, between fifty and one hundred thousand people live in Turkey [3]. We believe that today, the Chechen diaspora in Turkey maintains a sense of identity while simultaneously perceiving itself as a full-fledged part of the multinational Turkish people.

In examining the case of the Chechen diaspora in Syria, we note that after the collapse of the Ottoman Empire, it faced certain problems related to the fact that the local population perceived its representatives as people loyal to the former Ottoman authorities. For this reason, conflicts with the Arab and Druze populations were frequent [4, 386]. The rule of the Arab Socialist Renaissance Party (Baath) (since 1963), we believe, became the main factor determining the fate of the Chechen diaspora in Syria. During this period, a policy of forced assimilation was implemented: land confiscation, prohibition of the expression of cultural and linguistic identity [14]. The situation was further aggravated by Israel's occupation of the Golan Heights, which led to the scattered resettlement of the Chechens who had previously lived there [13]. Since the outbreak of the civil war in Syria in 2011, the situation in the country has not been conducive to full-fledged diaspora activities and has forced many Chechens to leave the country. The current number of Syrian Chechens does not exceed 5,500.

In Iraq, the Chechen diaspora largely followed the fate of Chechens in Syria, owing to the similarities in the socio-political processes of these two Middle Eastern states. As in Syria, the Ba'ath Party in Iraq pursued a strict assimilation policy, which hindered the integration of the Chechen diaspora into the country's political process. Following the fall of Saddam Hussein's regime, the country plunged into an ongoing period of political upheaval, which significantly degraded political life in Iraq and sidelined any diaspora activity. However, it should be noted that the Chechen diaspora retains a certain potential for development, primarily due to the active participation of the Chechen Republic's leadership, which is actively engaging with Chechens in Iraq, strengthening their role in the external aspects of the Iraqi political process [9]. It should be added that the number of Chechens in Iraq may be as high as 10,000 [12].

The Chechen diaspora has occupied its strongest position in Jordan. Due to the specific socio-political processes, the Hashemite Kingdom, since its founding in 1922, has largely viewed people from the North Caucasus, including Chechens, as an important element in the functioning of the state. In 1923, the Arab Legion was formed. Up to 80% of the personnel of its first units were recruited from the local Chechen community. Military service became a hereditary profession for many Chechens [14, 326]. From the very beginning of Jordan's existence as a state, Chechens and other Caucasian peoples have been guaranteed representation in parliament. According to an unwritten rule, they have three guaranteed seats in the House of Representatives, as well as a ministerial post in the government. The Chechen diaspora's position was also strengthened by the effects of the exodus of Palestinians to Jordan, who currently make up almost half of the kingdom's population. The situation of the Palestinian population in Jordan is a central and complex issue for the Kingdom, affecting demographics, national identity, and long-term political stability. Jordan's primary challenge is managing a population largely composed of Palestinians, while resolutely opposing policies that could lead to the displacement of more Palestinians from the West Bank or Gaza Strip, which it views as a threat to its national

sovereignty and identity. Therefore, Jordan's leadership relies on loyal ethnic groups, supporting their diaspora activity and participation in the political process [11]. Accordingly, the Jordanian authorities have not interfered with, but rather supported, the socio-cultural activities of the Chechen diaspora, which has opened numerous cultural, sports, and social centers. Chechens continue to play an important role in the life of the country, particularly in the army and security forces. Despite their small numbers, their share among the senior officers and generals is very high. The number of Chechens in Jordan currently stands at approximately 16,000.

Conclusion. In summary, the Chechen diaspora in the Middle East has undergone a long period of formation and development. The phenomenon of muhajir emigration, which led to the arrival of numerous people from the North Caucasus in the region, underlies the emergence of the Chechen diaspora in Middle Eastern countries such as Iraq, Jordan, Syria, and Turkey. People from Chechnya gradually began to occupy senior administrative and military positions even during the Ottoman Empire. Currently, the Chechen diaspora is experiencing the greatest difficulties in Iraq and Syria, primarily due to the difficult socio-political situation in these countries, as well as the demographic characteristics of the diaspora itself. The situation for the Chechen diaspora in Turkey is slightly better, but its ability to participate in the political process as an independent actor is limited by the structure of the modern Turkish state, which is tied to the construction of a Turkish identity for all peoples inhabiting the country. The most successful example of the development of the Chechen diaspora in the Middle East is Jordan, where, despite its insignificant presence, it has firmly established itself as a full-fledged participant in political life.

Список источников

1. Бибикова О.П. Проблема национальной идентичности в Иорданском Хашимитском королевстве // Экономические, социально-политические, этноконфессиональные проблемы афро-азиатских стран. 2020. №. 3. С. 326-331.
2. Бобровников В.О. Мухаджирство в" демографических войнах" России и Турции // Восток. Афро-азиатские общества: история и современность. 2010. №. 2. С. 76.
3. Гарсаев Л. М., Гарасаев Х. А. Генезис чеченской диаспоры Сирии и география ее расселения (по полевым материалам) // Вестник КНИИ РАН. Серия «Социальные и гуманитарные науки» №. 1. 2022. Т. 2. С. 10-20.
4. Гарсаев Л.М., Гарасаев Х.А.М., Магомедова Р.М. Известные государственные и военные деятели Турции чеченского происхождения // Образование и право. 2021. №. 8. С. 386.
5. Джабаева Т Ч., Магомедова А.М. Проблема эмиграции кавказских горцев в середине XIX в // Вестник науки и образования. 2022. №. 6-2 (126). С. 29-33.
6. Иорданская община чеченцев // Чечен Инфо. [Электронный ресурс] Режим доступа: http://www.checheninfo.ru/19442-1899-g-iordanskaya-obschina-chechencev.html (дата обращения 20.10.2025)
7. Исраилов А.Х. Фактор чеченской диаспоры в двусторонних отношениях Российской Федерации с государствами Ближнего Востока (на примере Турции, Иордании и Сирии) в 1991-2023 гг.: дис. канд. ист. наук: 5.6.7. Москва, 2025. 210 с.
8. Исраилов А.Х., Моргунова О.А. Чеченская диаспора в странах Ближнего Востока: к вопросу о поколенческой преемственности и социополитической динамике сообществ // Вестник ЯрГУ. Серия Гуманитарные науки. 2024. Т. 18. №. 3. С. 366-377.
9. Чеченская диаспора из Ирака укрепит связи с родиной по ряду направлений // Чечня сегодня. – [Электронный ресурс] – Режим доступа: https://chechnyatoday.com/news/349313 (дата обращения 10.10.2025)
10. Юсупова Г.М. Причины и этапы мухаджирства горцев Северного Кавказа во второй половине XIX в. // Мировая наука. 2021. №. 4 (49). С.324-328.
11. Al Husseini J. Jordan and the Palestinians // Atlas of Jordan. 2013. №. 1. P. 230-245.
12. Kailani W. Chechens in the Middle East: Between Original and Host Cultures // Belfer Center. – [Электронный ресурс] – Режим доступа:

https://www.belfercenter.org/index.php/publication/chechens-middle-east-between-original-and-host-cultures (дата обращения 13.10.2025)
13. Mason M., Dajani M., Eldin M. F. The Untold Story of the Golan Heights. The Untold Story of the Golan Heights. – L.: Bloomsbury Publishing, 2022. 248s.
14. Masri Z. Chechens of Syria… A minority integrated into its new home due to “Al-Baath Party” [Электронный ресурс] // Enab Baladi. – Режим доступа: https://english.enabbaladi.net/archives/2020/12/chechens-of-syria-a-minority-integrated-into-its-new-home-due-to-al-baath-party/
15. Mitaishvili-Rayyis Y. Regional Diasporas of the Middle East: Case Studies from Chechens in Jordan and Georgians in Iran // Georgian Foundation for Strategic and International Studies. – [Электронный ресурс]. Режим доступа: https://gfsis.org.ge/files/library/pdf/Eng--3513.pdf (дата обращения 13.10.2025)

References

1. Bibikova O.P. Problema natsional'noi identichnosti v Iordanskom Khashimitskom korolevstve // Ehkonomicheskie, sotsial'no-politicheskie, ehtnokonfessional'nye problemy afro-aziatskikh stran. 2020. №. 3. Pp. 326-331.
2. Bobrovnikov V.O. Mukhadzhirstvo v" demograficheskikh voinakh" Rossii i Turtsii // Vostok. Afro-aziatskie obshchestva: istoriya i sovremennost'. 2010. №. 2. S. 76.
3. Garsaev L. M., Garasaev KH. A. Genezis chechenskoi diaspory Sirii i geografiya ee rasseleniya (po polevym materialam) // Vestnik KNII RAN. Seriya «Sotsial'nye i gumanitarnye naukI» №. 1. 2022. T. 2. Pp. 10-20.
4. Garsaev L.M., Garasaev KH.A.M., Magomedova R.M. Izvestnye gosudarstvennye i voennye deyateli Turtsii chechenskogo proiskhozhdeniya // Obrazovanie i pravo. 2021. №. 8. Pp. 386.
5. Dzhabaeva T CH., Magomedova A.M. Problema ehmigratsii kavkazskikh gortsev v seredine XIX v // Vestnik nauki i obrazovaniya. 2022. №. 6-2 (126). S. 29-33.
6. Iordanskaya obshchina chechentsev // Chechen Info. – [Ehlektronnyi resurs] – Rezhim dostupa: http://www.checheninfo.ru/19442-1899-g-iordanskaya-obschina-chechencev.html (data obrashcheniya 20.10.2025)
7. Israilov A.KH. Faktor chechenskoi diaspory v dvustoronnikh otnosheniyakh Rossiiskoi Federatsii s gosudarstvami Blizhnego Vostoka (na primere Turtsii, Iordanii i Sirii) v 1991-2023 gg.: dis. kand. ist. nauk: 5.6.7. Moskva, 2025. 210 s.
8. Israilov A.KH., Morgunova O.A. Chechenskaya diaspora v stranakh Blizhnego Vostoka: k voprosu o pokolencheskoi preemstvennosti i sotsiopoliticheskoi dinamike soobshchestv // Vestnik YaRGU. Seriya Gumanitarnye nauki. 2024. T. 18. №. 3. S. 366-377.
9. The Chechen diaspora from Iraq will strengthen ties with their homeland in a number of areas // Chechnya Today. [Electronic resource] Access mode: https://chechnyatoday.com/news/349313 (accessed on 10.10.2025)
10. Yusupova G.M. The Reasons and Stages of the Muhajir Migration of the North Caucasus Highlanders in the Second Half of the 19th Century. World Science, 2021, No. 4 (49), pp. 324-328.
11. Al Husseini J. Jordan and the Palestinians. Atlas of Jordan. 2013. №. 1. Pp. 230-245.
12. Kailani W. Chechens in the Middle East: Between Original and Host Cultures // Belfer Center. – [Ehlektronnyi resurs] – Rezhim dostupa: https://www.belfercenter.org/index.php/publication/chechens-middle-east-between-original-and-host-cultures (data obrashcheniya 13.10.2025)
13. Mason M., Dajani M., Eldin M. F. The Untold Story of the Golan Heights. The Untold Story of the Golan Heights. L.: Bloomsbury Publishing, 2022. 248 s.
14. Masri Z. Chechens of Syria… A minority integrated into its new home due to “Al-Baath Party” [Ehlektronnyi resurs] // Enab Baladi. Rezhim dostupa: https://english.enabbaladi.net/archives/2020/12/chechens-of-syria-a-minority-integrated-into-its-new-home-due-to-al-baath-party/
15. Mitaishvili-Rayyis Y. Regional Diasporas of the Middle East: Case Studies from Chechens in Jordan and Georgians in Iran // Georgian Foundation for Strategic and International Studies. – [Ehlektronnyi resurs]. Rezhim dostupa: https://gfsis.org.ge/files/library/pdf/Eng--3513.pdf (data obrashcheniya 13.10.2025)

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Информационное недоверие и журналистские стратегии противодействия фейкам и deepfake-контенту

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Аннотация. ***Введение.*** В цифровой медиасреде фиксируется устойчивый рост информационного недоверия, связанный с ускоренным распространением фейковых новостей и синтетического deepfake-контента. Современные технологии генерации медиаматериалов радикально усложнили процедуры верификации и усилили скептическое восприятие новостных сообщений аудиторией. В условиях фрагментации информационных потоков и алгоритмической дистрибуции контента традиционные механизмы журналистского контроля испытывают структурные ограничения, что требует переосмысления профессиональных стратегий противодействия дезинформации. ***Цель.*** Провести аналитическое исследование феномена информационного недоверия и систематизировать журналистские стратегии противодействия фейкам и deepfake-контенту с учётом технологических, институциональных и образовательных факторов. ***Материалы и методы.*** В работе использованы материалы международных исследовательских отчётов, статистические данные социологических опросов, публикации профильных медиаорганизаций и аналитические обзоры, посвящённые дезинформации и медиадоверию. Методологическая база опирается на сравнительный анализ, критический обзор литературы, систематизацию эмпирических данных и интерпретацию статистических показателей, отражающих динамику доверия аудитории и эффективность применяемых практик. ***Результаты и обсуждение.*** Установлено устойчивое снижение уровня доверия к новостным источникам на фоне роста осведомлённости аудитории о манипулятивных технологиях. Показано, что deepfake-контент усиливает эффект тотального сомнения, при котором под подозрение попадает даже профессионально подготовленная журналистская информация. Проанализированы практики фактчекинга, автоматизированного обнаружения синтетических материалов и превентивного информирования аудитории; выявлены их функциональные ограничения и потенциал при совместном применении. Отмечена значимость межредакционного сотрудничества и взаимодействия с технологическими платформами для сдерживания масштабных дезинформационных кампаний. ***Заключение.*** Представленное исследование демонстрирует, что противодействие информационному недоверию требует комплексного сочетания журналистских, технологических и образовательных мер. Системная интеграция фактчекинга, инструментов верификации и программ медиаграмотности способствует повышению устойчивости информационного пространства и снижению деструктивного влияния фейков и deepfake-контента. Полученные выводы расширяют аналитическое понимание трансформации доверия в цифровых медиа и представляют практическую ценность для редакционных стратегий и исследовательских разработок в сфере коммуникаций.

Ключевые слова: информационное недоверие, фейковые новости, deepfake-контент, фактчекинг, медиаграмотность, журналистские стратегии, дезинформация, автоматическое обнаружение, цифровая эпоха, доверие аудитории

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Research article

Information distrust and journalistic strategies for countering fakes and deepfake content

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Abstract. ***Introduction.*** In the digital media environment, there is a steady increase in information distrust associated with the accelerated spread of fake news and synthetic deepfake content. Modern media generation technologies have radically complicated verification procedures and increased the skeptical perception of news reports by the audience. In the context of fragmentation of information flows and algorithmic content distribution, traditional journalistic control mechanisms are experiencing structural limitations, which require a rethink of professional strategies to counter disinformation. ***Goal.*** To conduct an analytical study of the phenomenon of information distrust and systematize journalistic strategies for countering fakes and deepfake content, taking into account technological, institutional, and educational factors. ***Materials and methods.*** The work uses materials from international research reports, statistical data from opinion polls, publications from specialized media organizations, and analytical reviews on disinformation and media trust. The methodological framework is based on comparative analysis, a critical review of the literature, the systematization of empirical data, and the interpretation of statistical indicators reflecting the dynamics of audience trust and the effectiveness of applied practices. ***Results and discussion.*** A steady decrease in the level of trust in news sources has been established against the background of increasing audience awareness of manipulative technologies. It is shown that deepfake content enhances the effect of total doubt, in which even professionally prepared journalistic information falls under suspicion. The practices of fact-checking, automated detection of synthetic materials, and preventive audience awareness are analyzed; their functional limitations and potential when used together are revealed. The importance of inter-editorial cooperation and interaction with technological platforms to deter large-scale disinformation campaigns was noted. ***Conclusion.*** The presented research demonstrates that countering information distrust requires a comprehensive combination of journalistic, technological, and educational measures. The system integration of fact-checking, verification tools, and media literacy programs helps to increase the stability of the information space and reduce the destructive impact of fakes and deepfake content. The findings expand the analytical understanding of the transformation of trust in digital media and are of practical value for editorial strategies and research developments in the field of communications.
Key words: information distrust, fake news, deepfake content, fact checking, media literacy, journalistic strategies, disinformation, automatic detection, digital age, audience trust

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Introduction. The modern information environment is experiencing a crisis of trust. A flood of unreliable information—from fake news to synthesized deepfake content—is undermining audiences' faith in the media. This topic is relevant because the widespread dissemination of disinformation threatens the quality of public information and democratic discourse. A phenomenon of "information distrust" is emerging, where consumers tend to doubt all messages, regardless of the source.

The aim of this study is to explore the scale of information distrust and analyze journalistic strategies aimed at countering fake information and deepfake content. To achieve this goal, the following objectives were addressed:

1) the manifestations of the crisis of trust in media in the digital age are characterized;

2) the main types of disinformation, including deepfake, and their impact on the audience are considered;

3) summarizes and evaluates the practices and tools used by journalism to verify facts and debunk false content;

4) Promising approaches to building trust were identified, including cooperation with technology platforms and improving media literacy among the population.

Materials and research methods. The study draws on a wide range of scientific publications, empirical observations, and statistical reports on disinformation generation technologies and detection methods. Securitymedia.org [1] described modern disinformation and deepfake content generation technologies; S. Anlen and R. Vázquez Llorante [2] studied algorithmic mechanisms for detecting deepfake in the electoral environment and identified the limitations of the tools; A. Majid [3] conducted a study on the perception of the credibility of journalistic materials and found a high degree of audience concern; Reuters [4] presented statistics on the decline in trust in traditional media and the growing popularity of TikTok news feeds; T. Sippy, F. Enock, J. Bright, and H. Margetts [5] assessed the level of concern about deepfake technologies and their impact on the information landscape; M. Stenciel, E. Ryan, and J. Luther [6] compared the dynamics of the spread of disinformation with the development of fact-checking institutions; M. Tulin, M. Hameleers, C. Talvitie, and C. de Vreese [7] examined journalistic countermeasure strategies in a changing media environment; K. Williams [8] offered a layman's guide to detecting synthetic content without deep technical skills. These contributions provided a rich body of empirical data and analytical insights to support argumentation.

The methodology is based on comparative analysis, a critical literature review, and a synthesis of statistical data from sociological studies. The work combines qualitative assessments of fact-checking practices and quantitative measurements of audience perceptions. The applied approach provided a systematic examination of information mistrust and the effectiveness of journalistic countermeasures.

Research results and their discussion. Analysis has shown that audience trust in news has declined significantly in recent years amid a surge in disinformation. According to global research, on average, only about 40% of consumers say they trust most news [4]. In comparison, less than a third of residents in some countries (for example, only 35% in the UK) express trust in media reports [3]. At the same time, the majority of the public is aware of the problem: approximately 56% of internet users are concerned about distinguishing truthful from fake news online [4]. Thus, more than half of consumers experience difficulty verifying the veracity of information, which defines the phenomenon of information distrust.

Deepfake technologies—methods for creating fake media content using artificial intelligence—have a particular impact on the growth of skepticism. Research has documented

near-universal public awareness of deepfake technologies: over 90% of respondents express concern about the spread of such technologies [5]. Importantly, 91.8% of respondents in one survey agreed that deepfake content increases distrust in information and is capable of manipulating public opinion [5]. Thus, the emergence of plausible fake videos and audio recordings further exacerbates the crisis of trust. Indeed, new generations of fakes are becoming virtually indistinguishable from reality, leading to reputational crises, market panic, and a general "erosion of trust" in the media. Experts note that generative AI and deepfakes have radically increased the credibility of disinformation: these are no longer crude sensationalist hoaxes, but texts, images, and videos carefully stylized to resemble genuine news, often distributed through online bots and anonymous messaging channels [1]. As a result, consumers are beginning to a priori doubt any information they receive. This is also confirmed by the sociological background: public opinion is increasingly characterized by distrust of official reports, a sense of informational uncertainty, and the expectation of a catch.

Meanwhile, the journalistic community and the news industry have developed a number of strategies to counter the influx of fake news and gradually restore trust [7]. The media sphere's key response is fact-checking (Table 1).

Table 1. Fact-checking (compiled by the author based on [6, 7])

Paragraph	Details
Tool of struggle	Fact-checking is a quick and efficient way to verify the veracity of information.
Projects in 2008	About ten professional initiatives
Projects in 2022	More than 420 initiatives in over a hundred countries
Organizational formats	Independent structures and divisions of major media outlets at the international and local levels
Main tasks	Promptly exposes false statements made by politicians, verifies viral news and other falsehoods
Significance for the industry	The expansion of the fact-checking network demonstrates the willingness of journalists to invest resources in restoring the credibility of the public information space.

In addition to the growth of fact-checking institutions, editorial offices are also implementing new technological tools to identify fake content. A class of specialized programs for the automatic detection of deepfake has emerged, ranging from video image analyzers to synthesized speech detectors (Table 2).

Table 2. Tools and limitations of automated deepfake detection (compiled by the author based on [8])

Paragraph	Details
Type of tools	Automatic video analysis and speech synthesis recognition
Examples of services	Deepware Scanner, InVid, Hive, and others
Reliability of algorithms	Algorithmic methods lag behind generative models; frequent false positives
Detector vulnerabilities	Adding noise or filters bypasses detection
Limitations of interpretation	The "70% synthetic content" label does not indicate which elements of the image have been modified.

The risks of blind trust	Excessive faith in AI reduces attentiveness and leads to erroneous decisions.
Test method	Frame-by-frame analysis, metadata verification, source search, and multiple checks with different detectors with critical analysis

A separate area of counteraction is preventative information and audience education (Table 3). Since a significant portion of disinformation is spread through social media and messaging apps, where journalistic oversight is limited, increasing media literacy has become an important task. Experts emphasize that, in the long term, audience education is no less important than technical filters [1].

Table 3. Preventive information and education of the audience (compiled by the author based on [1])

Measure	Description
Preventive information	Dissemination of recommendations for recognizing fakes on social networks and messengers
Improving media literacy among the population	Educational campaigns and guides designed to develop skills for critical evaluation of media content
Manuals and guides	Publications by international organizations (e.g., UNESCO's Handbook on Countering Fake News and Disinformation)
Contents of educational materials	Described methods of verifying information and recommendations for mastering fact-checking techniques
Editorial practices	Publication of exposés, fact-checking sections on websites, online Q&A forums on news reliability
Expected effect	Identifying false messages, developing critical thinking, and preventing information attacks

Finally, the collective efforts of the journalistic community and collaboration with other actors—tech companies, governments, and the scientific community—help effectively counter disinformation. In the 2020s, international alliances and projects emerged that pool the resources of various editorial offices to combat fake news (for example, IFCN – the International Fact-Checking Network). Some jurisdictions have created legal frameworks for such cooperation. A prime example is the EU's Digital Services Act (DSA), which, among other things, requires major online platforms to cooperate with reputable fact-checking organizations and increase the transparency of their algorithms [7]. This allows journalists and fact-checkers to more quickly identify widespread false narratives and flag questionable content for users. Globally, such initiatives reflect the understanding that restoring trust in information requires collaboration between the media industry, the IT sector, and society. Simply debunking every rumor is not enough; it is necessary to create an ecosystem in which disinformation has a reduced chance of spreading.

The results obtained paint a contradictory picture. On the one hand, trust in traditional media has declined significantly in recent years, as confirmed by both survey data and audience behavior. Information distrust has become a tangible social factor: a significant portion of society a priori doubts the veracity of news. This has been driven by objective factors: an avalanche of fake content in digital media, the politicization of the news agenda, examples of outright lies uncovered in the media, and, of course, the emergence of technologies like deepfakes, which literally blur the boundaries of reality. High-profile incidents regularly occur in which deepfakes are used to create false statements impersonating famous individuals or to disseminate staged events.

Although many of these cases are quickly exposed (for example, a deepfake video calling for the Ukrainian president to lay down arms was promptly debunked and removed from social media by users and official sources), their very existence undermines the overall atmosphere of trust. People begin to feel that "nothing can be trusted," that "everything is a lie," and as a result, even conscientious journalism comes under suspicion.

On the other hand, the journalistic community is not remaining passive – it is developing adaptive strategies, trying to restore lost trust or at least prevent its further decline. The expansion of fact-checking practices can be seen as a positive trend. The widespread creation of fact-checking departments in editorial offices, the emergence of independent fact-checking platforms, and international cooperation in this area have significantly increased the likelihood that false information will be identified and publicly refuted. According to the data presented, the growth of such projects was particularly intense in the 2010s, and there are now hundreds of them worldwide. This means that society has mechanisms for correcting post-truth: fake news is not ignored; it is exposed, often using striking visual comparisons of "fact vs. fiction" and widespread dissemination of the verification results. For example, when a resonant rumor or falsehood emerges, within literally 24 hours, leading media outlets and fact-checking websites publish materials analyzing and explaining what is true and what is fiction. Such a prompt response can partially neutralize the harm caused by disinformation.

However, it must be acknowledged that the effectiveness of fact-checking has its limits. Firstly, retractions don't always reach the entire audience that saw the original fake—especially in the context of algorithmic social media feeds, where corrections may simply not reach the user. Secondly, some audiences have developed a cynical view of the retractions themselves (as in, "everyone sticks to their own opinion"). Thirdly, the speed at which fake news spreads often outpaces the response of journalists. Therefore, while fact-checking is undoubtedly necessary and useful, it alone is not enough to fully restore trust.

Technical solutions, such as deepfake detection algorithms, are not yet a panacea. Research has shown that current detectors are too narrowly specialized and can fail when encountering new types of synthetic content. Moreover, attackers are beginning to deliberately adapt their fakes to known detection algorithms, turning the situation into a kind of race. Consequently, journalists cannot rely solely on software tools; they need a combination of technology, analytical skills, and common sense. The need for "proactive content authentication" is becoming increasingly prominent in professional discourse: that is, the implementation of standards in the media sphere whereby the original, reliable content is marked with special labels (digital watermarks, certificates of authenticity, etc.) [2].

Initiatives like these (such as the Content Authenticity Initiative, promoted by several major media outlets and tech companies) aim to enable users to verify whether an image or video has been edited and trace its chain of origin. While these technologies are still in development, they could significantly increase the transparency of information flows. Journalists are interested in implementing such solutions because they will make it easier for them to verify the authenticity of materials, especially visual ones, and thereby strengthen audience trust.

A key component of the problem under discussion is audience media literacy. Many researchers agree that, alongside efforts to combat content production and distribution, it's necessary to strengthen consumers' resilience to disinformation. If readers/viewers are equipped with basic fact-checking skills—they can find the original source of a news story, critically evaluate a headline, and recognize an emotionally charged tone or obvious contradiction—fake news loses its power. Therefore, media literacy training initiatives, courses for schoolchildren and students, and educational programs on television and online are an integral part of the strategy. Of course, the results of such efforts will not be immediately visible. However, in the long term, cultivating a critically thinking audience creates the foundation for a sustainable information space. One can draw an analogy with the immune system: media literacy is a kind of inoculation against the viruses of lies. Combined with journalistic "sanitary measures" (fact-

checking, filters, transparency), such an immune layer in society will significantly complicate the lives of disseminators of fake news.

Finally, journalism is rethinking its ethical and professional approaches to re-earn trust. Editorial boards are striving for greater openness with audiences: explaining their information-gathering methodology, disclosing data sources, and publicly acknowledging and correcting errors. This transparency and accountability are intended to demonstrate that quality media have nothing to hide and are committed to the truth. Some publications are introducing the practice of "news analysis"—in which a journalist, via video or podcast, explains in detail how a report was prepared, how facts were verified, etc. This increases audience trust by demonstrating the integrity of the process. Furthermore, the concept of "slow news" has emerged, contrasting it with the instantaneous flow of social media: such projects produce less frequently but offer deeply researched, verified materials, thereby restoring respect for the reliable word. All of this is part of a broader strategy to restore the media's reputation as a trustworthy institution.

To summarize the discussion, it's worth emphasizing: information distrust is a complex problem, and journalistic strategies must evolve to meet new challenges. Combating disinformation is not an episodic campaign, but an ongoing process that requires innovation, collaboration, and adaptability. As one analytical review aptly notes, in the battle between truth and fabrication, the winner will be the one who can adapt more quickly and anticipate the opponent's moves, not simply refute existing disinformation more effectively. Journalism, armed with both technology and traditional values of accuracy and integrity, plays a key role in this struggle.

Conclusion. The study found that in the digital age, media are facing an unprecedented crisis of trust caused by the spread of fake and deepfake information. The key findings can be summarized as follows. First, the level of informational mistrust is high: a significant portion of the audience doubts the veracity of news, a fact supported by statistical data (trust in news is around 40% or lower). This mistrust is exacerbated by the impact of new technologies: deepfake content is recognized as an additional threat, capable of undermining faith in the documentary nature of media. Second, journalism has developed a set of strategies to counter this threat. These include strengthening fact-checking (the creation of hundreds of fact-checking projects worldwide), the widespread adoption of content verification technologies (fake detectors, big data analysis), the promotion of initiatives to label reliable materials and alert audiences to potential fakes, and increased editorial transparency. Thirdly, special attention is paid to audience education: improving media literacy is recognized as a necessary condition in the fight against disinformation, along with technical and journalistic measures.

The scientific and practical significance of the obtained results lies in their confirmation that the crisis of trust in information has objective causes, but it is not fatal. Journalistic strategies adapted to the new conditions can curb the spread of falsehoods and gradually restore trust. The scientific value of the work lies in its comprehensive examination of the phenomenon of information mistrust – both from its social manifestations and through the prism of the media industry's responses. Its practical significance lies in the generalization of effective methods for countering disinformation, which can be used by editorial offices and educational institutions when developing training, policies, and recommendations.

Summarizing the results, we can conclude that informational distrust is a complex but surmountable challenge. The media community, relying on principles of objectivity and employing new tools, is consistently combating fakes and deepfake content. Success in this fight will depend on continued innovation—the development of verification algorithms, the implementation of transparency standards—and on strengthening the alliance between journalists and audiences. Only by rebuilding trust—step by step, news by news—will the media be able to fulfill its purpose in a democratic society. In a world where lies can be generated by machines in seconds, truth and trust acquire special value: they become the very capital without which neither journalism nor public dialogue can exist.

Список источников

1. Фейки нового поколения: технологии против информационной подделки [Электронный ресурс] // securitymedia.org. 2025. URL: https://securitymedia.org/info/feyki-novogo-pokoleniya-tekhnologii-protiv-informatsionnoy-poddelki.html (дата обращения: 20.07.2025)
2. Anlen S., Vázquez Llorante R. Spotting Deepfakes in an Election Year: How AI Detection Tools Work and Sometimes Fail [Электронный ресурс] // Reuters Institute. 2024. URL: https://gijn.org/stories/spotting-deepfakes-election-year/ (дата обращения: 19.07.2025)
3. Majid A. Almost seven in ten people worry they are being lied to by journalists, according to latest Edelman Trust survey [Электронный ресурс] // Press Gazette. — 2022. URL: https://pressgazette.co.uk/news/almost-seven-in-ten-people-worry-they-are-being-lied-to-by-journalists-according-to-latest-edelman-trust-survey/ (дата обращения:17.07.2025)
4. Reuters. Fewer people trust traditional media, more turn to TikTok for news, report says [Электронный ресурс] // Reuters. 2023. URL: https://www.reuters.com/business/media-telecom/fewer-people-trust-traditional-media-more-turn-tiktok-news-report-says-2023-06-13/ (дата обращения: 20.07.2025)
5. Sippy T., Enock F., Bright J., Margetts H. Behind Deepfake 8: Create 90 concerned [Электронный ресурс] // The Alan Turing Institute. б. г. URL: https://www.turing.ac.uk/news/publications/behind-deepfake-8-create-90-concerned (дата обращения: 18.07.2025)
6. Stencel M., Ryan E., Luther J. Misinformation spreads but fact checking has leveled off [Электронный ресурс] // ReportersLab. 2023. URL: https://reporterslab.org/2023/06/21/misinformation-spreads-but-fact-checking-has-leveled-off (дата обращения: 19.07.2025)
7. Tulin M., Hameleers M., Talvitie C., de Vreese C. How Can Journalists Strengthen Their Fight Against Misinformation in a Changing Media Landscape? [Электронный ресурс] // VIEW Journal of European Television History and Culture. 2024. Т. 13, № 25. С.28–41. URL: https://doi.org/10.18146/view.324 (дата обращения: 20.07.2025)
8. Williams K. What Journalists Should Know About Deepfake Detection in 2025: A nontechnical guide [Электронный ресурс] // Columbia Journalism Review. 2025. URL: https://www.cjr.org/tow_center/what-journalists-should-know-about-deepfake-detection-technology-in-2025-a-non-technical-guide.php (дата обращения: 20.07.2025)

References

1. Feiki novogo pokoleniya: tekhnologii protiv informatsionnoi poddelki [Ehlektronnyi resurs] // securitymedia.org. — 2025. URL: https://securitymedia.org/info/feyki-novogo-pokoleniya-tekhnologii-protiv-informatsionnoy-poddelki.html (data obrashcheniya: 20.07.2025)
2. Anlen S., Vázquez Llorante R. Spotting Deepfakes in an Election Year: How AI Detection Tools Work — and Sometimes Fail [Ehlektronnyi resurs]. Reuters Institute. 2024. URL: https://gijn.org/stories/spotting-deepfakes-election-year/ (data obrashcheniya: 19.07.2025)
3. Majid A. Almost seven in ten people worry they are being lied to by journalists, according to latest Edelman Trust survey [Ehlektronnyi resurs]. Press Gazette. 2022. URL: https://pressgazette.co.uk/news/almost-seven-in-ten-people-worry-they-are-being-lied-to-by-journalists-according-to-latest-edelman-trust-survey/ (data obrashcheniya:17.07.2025)
4. Reuters. Fewer people trust traditional media, more turn to TikTok for news, report says [Ehlektronnyi resurs] // Reuters. 2023. URL: https://www.reuters.com/business/media-telecom/fewer-people-trust-traditional-media-more-turn-tiktok-news-report-says-2023-06-13/ (data obrashcheniya: 20.07.2025)
5. Sippy T., Enock F., Bright J., Margetts H. Behind Deepfake 8: Create 90 concerned [Ehlektronnyi resurs]. The Alan Turing Institute. b. g. URL: https://www.turing.ac.uk/news/publications/behind-deepfake-8-create-90-concerned (data obrashcheniya: 18.07.2025)
6. Stencel M., Ryan E., Luther J. Misinformation spreads but fact checking has leveled off [Ehlektronnyi resurs]. ReportersLab. 2023. URL: https://reporterslab.org/2023/06/21/misinformation-spreads-but-fact-checking-has-leveled-off (data obrashcheniya: 19.07.2025)
7. Tulin M., Hameleers M., Talvitie C., de Vreese C. How Can Journalists Strengthen Their Fight Against Misinformation in a Changing Media Landscape? [Ehlektronnyi resurs]. VIEW Journal of

European Television History and Culture. 2024. T. 13, № 25. Pp. 28–41. URL: https://doi.org/10.18146/view.324 (data obrashcheniya: 20.07.2025)
8. Williams K. What Journalists Should Know About Deepfake Detection in 2025: A nontechnical guide [Ehlektronnyi resurs]. Columbia Journalism Review. 2025. URL: https://www.cjr.org/tow_center/what-journalists-should-know-about-deepfake-detection-technology-in-2025-a-non-technical-guide.php (data obrashcheniya: 20.07.2025)

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Философско-политические аспекты Конституционных прав и свобод человека и гражданина в Российской Федерации

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Аннотация. ***Введение.*** В статье рассматриваются философско-политические аспекты определения сущности прав и свобод человека и гражданина в Российской Федерации. ***Цель.*** Выявление философско-политических аспектов определения в Конституции Российской Федерации сущности прав и свобод человека и гражданина, и особенностей деятельности российского государства и его органов по их обеспечению и защите. ***Материалы и методы.*** В исследование использованы Конституция Российской Федерации, другие законодательные акты РФ и международные документы, содержащие описание сущности прав и свобод человека и гражданина в СССР, Российской Федерации и иных государствах. Методами лингвистического, исторического, формально-юридического и сравнительно-правового анализа выявлялись и описывались философско-политические аспекты соотношения понятий прав и свобод человека, его обязанностей в российском конституционном праве и международной правовой системе. ***Результаты и обсуждение***. В ходе исследования выявлены существенные различия философских, политологических и юридических научных школ о сущности феноменов, обозначаемых термином «права и свободы человека и гражданина», вследствие чего основные положения Всеобщей декларации прав человека не были в неизменном виде закреплены в юридических документах государств, но приняты в качестве ориентиров национальных доктрин, определяющих содержание прав и свобод человека и гражданина в большинстве государств. ***Заключение.*** Проведенное исследование позволяет утверждать, что в России в конкретно исторических условиях создана своеобразная система прав и свобод человека и гражданина. Ее основу составляют Конституция РФ и иные документы, содержание которых определяют доминирующие в обществе культура, мировоззрение и законодательство. Система прав и свобод человека и гражданина включает традиционные нормы естественного права и властно изменяемые нормативы общественных отношений, приобретающие временный, ситуативный характер. В России гарантами обеспечения прав и свобод человека и гражданина являются Президент РФ, другие публичные органы власти, государственные органы и общественные объединения, уполномоченные выполнять правоохранительные и правозащитные функции.

Ключевые слова: права, свободы, обязанности человека и гражданина, конституционные гарантии, обеспечение и защита прав и свобод человека, правоохранительные органы.
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Research article

Philosophical and political aspects of constitutional human and civil rights and freedoms in Russian Federation

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Abstract. ***Introduction.*** The article examines the philosophical and political aspects of determining the essence of human and civil rights and freedoms in the Russian Federation. Goal. Identification of philosophical and political aspects of the definition in the Constitution of the Russian Federation of the essence of human and civil rights and freedoms and the specifics of the activities of the Russian state and its bodies to ensure and protect them. **Goal.** Identification of philosophical and political aspects of the definition in the Constitution of the Russian Federation of the essence of human and civil rights and freedoms and the specifics of the activities of the Russian state and its bodies to ensure and protect them. ***Materials and methods.*** The study uses the Constitution of the Russian Federation, other legislative acts of the Russian Federation and international documents describing the essence of human and civil rights and freedoms in the USSR, the Russian Federation and other states. The methods of linguistic, historical, formal-legal and comparative-legal analysis revealed and described the philosophical and political aspects of the relationship between the concepts of human rights and freedoms, his duties in Russian constitutional law and the international legal system. ***Results and discussion.*** The study revealed significant differences between philosophical, political science and legal scientific schools about the essence of the phenomena referred to by the term "human and civil rights and freedoms", as a result of which the main provisions of the Universal Declaration of Human Rights were not fixed in the legal documents of states, but adopted as guidelines for national doctrines defining the content of rights and freedoms. a person and a citizen in most countries.***Conclusion.*** The conducted research allows us to assert that in Russia, in specific historical conditions, a peculiar system of human and civil rights and freedoms has been created. It is based on the Constitution of the Russian Federation and other documents, the content of which is determined by the dominant culture, worldview and legislation in society. The system of human and civil rights and freedoms includes traditional norms of natural law and imperiously modifiable norms of social relations, which acquire a temporary, situational character. In Russia, the guarantors of ensuring human and civil rights and freedoms are the President of the Russian Federation, other public authorities, state bodies and public associations authorized to perform law enforcement and human rights functions.

Keywords: human and civil rights, freedoms, duties, constitutional guarantees, ensuring and protecting human rights and freedoms, law enforcement agencies.
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Introduction. Identifying the philosophical and political aspects of human and civil rights and freedoms is crucial for understanding the essence of the phenomenon denoted by this term and its appropriate use in the Constitution of the Russian Federation and national legislation, as well as the activities of state bodies tasked with ensuring their observance, protection, and restoration. Consequently, research into the philosophical and political aspects of constitutional human and civil rights and freedoms acquires not only scientific and educational but also practical political and legal significance for the Russian state and its law enforcement and human rights agencies.

Research materials and methods. The research materials included the Constitution of the Russian Federation, other legislative acts of the Russian Federation, and international documents describing the essence of human and civil rights and freedoms in the USSR, the Russian Federation, and other countries.

The use of linguistic, historical, formal-legal and comparative legal analysis methods in the study allowed us to identify and describe the philosophical and political aspects of the relationship between the concepts of human rights and freedoms, human responsibilities in Russian constitutional law and the international legal system, as well as the main areas of activity of the state and its bodies that guarantee the provision, observance, protection and restoration of human and civil rights and freedoms in the Russian Federation.

Research results and their discussion. A linguistic analysis of the legal term “human rights”, widely used in public practice, reveals its complex structure, in which the word “right” is interpreted in Russian as “power, strength, will, freedom of action given by someone or recognized by custom; power and will within conditional limits” [2, p. 519], and also as “a set of norms and rules established and protected by state authority, regulating relations between people in society…, a state-protected, legalized opportunity, freedom to do something, to implement something…; the ability to act, to behave in some way…” [3, p. 467].

The given definitions of the term “law” indicate the diversity of reflection of the essence of the phenomenon it designates in public and individual consciousness, giving rise to scientific discussions in which two opposing concepts of natural and positive law have been developed and are being developed.

The problems of defining the essence of the phenomenon of human rights are considered by all the humanities that utilize the official-authoritative paradigm of positive law, which contrasts morally based natural law with positive law , which, in the understanding of the proponents of this paradigm, makes legally significant only the rules of social relations officially enshrined in state laws and supported by the methods of political power. Moreover, as V.S. Narsesyants pointed out, "the official-authoritative reality of positive law acts as the highest authority in the question of what constitutes law at a given time and in a given place" [4, p. 7].

In domestic jurisprudence, the term “human rights” is used, as a rule, in a broad sense to denote the rules that prevail in society and are applied to protect the dignity of and freedom each individual person .

At the same time, since ancient times, debates have been ongoing about the social benefits and harms of individual freedom. In particular, Plato argued that "complete freedom and independence from all authority is far worse than moderate subordination to others" [5], and therefore, in an ideal state, there should be no absolute individual freedom, which must be subordinated to the interests of society as a whole, as expressed by the state [5].

Later, the term “freedom” in philosophy began to denote “a person’s ability to actively engage in activity in accordance with his intentions, desires, and interests, during which he achieves the goals he has set for himself. The practical realization of the internal freedom of the

individual is achieved thanks to the objective possibility, or external freedom, for such activity" [6, p. 567].

According to modern philosophers, the necessary prerequisites for freedom are created by the embodiment of natural conditions, social and economic relations, which determine the range of specific human interests and opportunities for realizing their goals. In this regard, the Newest Philosophical Dictionary defines freedom as a cultural universal of an objective nature, capturing the possibilities of activity and behavior in the absence of external goal-setting [7, p. 608].

Consequently, the term "freedom" can mean the ability of a person to exercise his will and desire to act in accordance with his own choice of goals, forms and methods of behavior, independently of other people, but taking into account the real political, economic, social and other conditions in which the individual finds himself.

Thus, the relationship between the phenomena denoted by the terms "rights" and "freedoms" turns out to be directly dependent on the actual conditions of human life, created not only by natural (environmental), but also by social conditions formed by society under the influence of the state or without its participation. The importance of human and civil rights and freedoms for the Russian state is described in Article 2 of the Constitution of the Russian Federation, which establishes that " man, his rights and freedoms are the highest value", and "the recognition, observance and protection of human and civil rights and freedoms is the responsibility of the state" [1]. At the same time, Article 18 of the Constitution of the Russian Federation recognizes that "human and civil rights and freedoms are directly applicable...", determining "...the meaning, content and application of laws, the activities of the legislative and executive authorities, local self-government and ensured justice [1].

The state's recognition of the socio-political significance of regulating the rights and freedoms of individuals entering into relations with other members of society compels public authorities to develop and implement national laws in social practice in the territory under their control, defining the norms for the application of human rights and freedoms by creating conditions for activities permitted by law, as well as limiting the right to possess and use such rights and freedoms, or to protect and restore them in cases of their violation by public authorities, public associations, or individuals.

According to Articles 10 and 11 of the Constitution of the Russian Federation, the implementation of the state's control and regulatory functions is ensured by its federal and regional bodies within the limits of their jurisdiction and powers, delimited by legislation and relevant treaties [1].

By means of treaties and other legal norms formalized in laws, the state establishes social relations based on legal norms and maintains them using the means of power. At the same time, the methods of political power transform the law into a regulator of the possible conditions for the realization of individual freedoms, and the content of ideas about human rights and freedoms is politicized, while discussions about the essence of human rights and freedoms contribute to the politicization of public consciousness, the actualization of legislation and other cultural values dominant in society in the specific historical conditions of place and time. Taking into account these circumstances, when preparing the draft Universal Declaration of Human Rights, the representative of Canada, Ralph Maybank, expressed his opinion on the reasons for the disagreements regarding the content of the main provisions of the document under discussion: " *Every people has its own established views on human rights. These views are based on the legal and philosophical conception adopted in a particular state. As a result of this diversity, 150 amendments were proposed to the Universal Declaration of Human Rights. Each of them provoked debate" [8]*.

At the suggestion of the Canadian delegation, supported by the majority of members of the preparatory commission, the document under discussion acquired a recommendatory nature and was proposed for independent implementation in the legislation of each state, taking into account national circumstances. Consequently, the Universal Declaration of Human Rights *did not become a generally binding directive, and in its final version,* adopted by resolution 217A (III), The UN General Assembly of 10 December 1948 stated that " as a common standard of achievement for all peoples and all nations, every individual and every organ of society, keeping this Declaration constantly in mind, shall strive by teaching and education to promote respect for these rights and freedoms and by progressive measures, national and international, to secure their universal and effective recognition and observance, both among the peoples of Member States and among the peoples of territories under their jurisdiction" [9]. But even in this compromise form, the content of the declaration did not satisfy the delegations of eight states (USSR, Belarus, Ukraine, Czechoslovakia, Poland, Yugoslavia, Canada, Saudi Arabia), which refused to participate in the vote for its adoption [8].

The Universal Declaration of Human Rights was not formalized by international treaties binding on the states that signed it, and was not adopted by any state as a legally binding document, but it serves as a moral guide for national legislation. Thus, Russia's recognition of the fundamental principles for determining human rights and freedoms was recorded in the Resolution of the Supreme Soviet of the RSFSR of November 22, 1991, No. 1920-1 "On the Declaration of the Rights and Freedoms of Man and Citizen," detailed in the Constitution of the Russian Federation in 1993 [10], in specific federal laws, as well as in the constitutions, charters, and laws of the constituent entities of the Russian Federation.

However, in the last decade, problems have arisen in resolving legal conflicts between Russian legislation and decisions of the European Court of Human Rights (ECHR), which often conflict with the norms of the Russian Constitution. In this regard, the Constitutional Court of the Russian Federation, in its ruling of July 14, 2015, No. 21-P, formulated a rule according to which state bodies may appeal to the Constitutional Court of the Russian Federation to justify their refusal to implement decisions of the ECHR recognized by the Constitutional Court of the Russian Federation as contrary to the Russian Constitution [11].

The provisions of the Declaration and international treaties that do not contradict the Constitution of the Russian Federation and do not entail restrictions on human and civil rights and freedoms in the Russian Federation, in accordance with Part 4 of Article 15 and Article 79 of the Constitution of the Russian Federation, have become an integral part of national legislation. They were taken into account in the development of Chapter 2 of the Constitution of the Russian Federation, entitled "Human and Civil Rights and Freedoms" [1]. Under the terms of Article 17 of the Constitution of the Russian Federation, these norms are recognized and guaranteed by the state in accordance with the principles and norms of international law [1].

Even after the Russian Federation’s withdrawal from some international human rights organizations, as Russian President V.V. Putin said, our state does not abandon the generally recognized principles of the Universal Declaration of Human Rights and is ready to cooperate with partners in the human rights sphere, to comply with mandatory international covenants that are an integral part of the Russian legal system [12].

However, the content of the Universal Declaration of Human Rights and other UN legal acts prepared in its development, continues to give rise to numerous controversies, the results of which, for example, the United States used to refuse to sign the International Convention on the Rights of the Child and to retain numerous types of death penalty, while Ukraine, the Baltic States and some NATO member states constantly violate the principles of equal rights of people,

regardless of their national or religious affiliation, ideological and other differences, proclaimed in the Declaration.

For such reasons, questions about the philosophical and political aspects of human rights and freedoms, which are resolved by all states, communities and individuals independently within the limits determined by their understanding of justice and the ethical foundations of tolerance, remain relevant for modern humanities.

At the same time, the political elites of many countries selectively use certain findings of scientific and cognitive debates to justify legislatively establishing ideological standards of approved or condemned human behavior in the societies they govern, which have been dominant for a time. National systems of judicial and extrajudicial assessments of human actions in various contexts, as well as methods of rewarding compliance with legally established standards of behavior or punishing their violations, are formed on the basis of these laws. At the same time, certain ruling political institutions—government bodies and/or political parties, religious denominations—permit and encourage extraordinary deviations in so-called "positive directions" from the established norms of socially significant citizen behavior, including various violations of the principles of natural family and marital relations and other perversions.

Among evaluative judgments about human behavior, the concept of "correctness" occupies a prominent place. It denotes the conformity of the assessed actions with laws and national, religious, corporate, and other rules, which can vary significantly across communities and time periods. Consequently, the importance of rules, norms, and principles recognized by the majority of humanity as regulating human behavior in various spheres of life increases. However, not all communities, formed according to national, religious, ideological, and other criteria, recognize the norms of international law and implement them for the people living in the territories under their control. In particular, Western European and Atlantic states, aspiring to global domination, impose "democratic rules" on all of humanity, which are far removed from generally accepted norms of international law and contain double standards for assessing the security of human rights and freedoms in friendly and unfriendly states.

Following the best traditions of international law, the Russian Federation, in Article 2 of the Constitution of the Russian Federation, recognized the individual, his rights, and freedoms as the highest value of the state, and the observance and protection of human and civil rights and freedoms as the state's priority responsibilities [1]. The legally formalized obligations of the Russian state to ensure the full realization of human and civil rights and freedoms, as defined by the Constitution of the Russian Federation, are referred to as "constitutional guarantees." Their observance is ensured by the enshrinement in Part 1 of Article 15 and Article 18 of the Constitution of the Russian Federation of the principle of direct and immediate application of constitutional norms with respect to human and civil rights and freedoms [1].

Given the wide diversity of human activity, constitutional guarantees form a multifaceted system of state obligations, encompassing legal, political, socioeconomic, and spiritual aspects. Consequently, there arises a need for sectoral differentiation and specialization of public authorities and public associations tasked with ensuring the implementation, protection, defense, and restoration of constitutional human and civil rights and freedoms in general or in specific areas of life.

The formal legal basis for constitutional guarantees of respect for human and civil rights by the Russian state are legally enshrined obligations, which are the means, methods and ways of implementing human and civil rights and freedoms by authorized law enforcement agencies of the state and (or) human rights public associations, formalized by laws and other legal acts.

Constitutional guarantees of the state are conventionally divided into objective (provided by the state for all people regardless of their personal qualities) and subjective (implemented by a person at his discretion), as well as general (according to Part 1 of Article 45 of the Constitution of the Russian Federation, they serve as conditions and means of protecting all human rights and freedoms or a significant part of them) and special (relate to specific possible circumstances, situations, in which the definition of human and civil rights and freedoms is required).

The highest legal force for guarantees of human rights and freedoms in Russia is intended to be ensured by the political system, whose duties, in accordance with Articles 45, 46, 53, 55, 56, 60, 61 of the Constitution of the Russian Federation, include providing opportunities for the realization by every person on the territory of the state and every citizen of the Russian Federation, regardless of their place of residence, of all rights and freedoms enshrined in Russian legislation and the norms of international law [1].

At the same time, contradictions arise between the liberal-pluralist interpretation of the principles of ensuring the rights and freedoms of the individual and the rights and freedoms of other people who have a need to realize their own rights and freedoms through objects claimed by other people. An attempt at a universal solution to such contradictions was the proclamation in Part 3 of Article 17 of the Constitution of the Russian Federation of the peacekeeping principle of conflict-free social relations, according to which the exercise of human and civil rights and freedoms should not violate the rights and freedoms of others [1]. The application of this principle of conflict-free resolution of disputes requires mutual compliance on the part of interacting people, who are not always prepared to self-limit their rights and freedoms. As a result, conflict resolution requires an arbitrator, judge, or mediator capable of finding compromise solutions to contentious issues and, if necessary, using methods of authoritative coercion to end conflicts. The state possesses such methods, distributing its functions among the state bodies it has created, among which the state authorities stand out.

The highest official of the Russian Federation, ensuring guarantees of human and civil rights and freedoms, is the President of the Russian Federation. Upon assuming office, he or she takes an oath containing a vow to respect and protect human and civil rights and freedoms, to observe and defend the Constitution of the Russian Federation, to protect the sovereignty and independence, security and integrity of the state, and to faithfully serve the people [1]. When signing federal laws and decrees, the President of the Russian Federation evaluates their impact on ensuring human rights and freedoms and, if there is a threat of their violation, returns the bill to the Federal Assembly of the Russian Federation for revision.

A structural and functional analysis of the system of state authorities, local government bodies, and public associations involved in ensuring constitutional guarantees of human and civil rights and freedoms in the Russian Federation allows us to identify a set of bodies and organizations within society that perform certain state functions in protecting constitutional human and civil rights in our country. These bodies are authorized to apply regulatory and control measures to public authorities, public associations, and individuals in accordance with Russian law [13].

Article 46 of the Constitution of the Russian Federation guarantees every person judicial protection of his rights and freedoms, the possibility of appealing in court the decisions and actions (or inaction) of public authorities, public associations and officials. In the Russian Federation, the legal basis for the activities of courts, which are authorized to administer justice in accordance with Articles 118-128* of the Constitution of the Russian Federation and the principles of justice set out in Part 1 of Article 19, Articles 21-25; 4647-51, 54 of the Constitution of the Russian Federation [1; 20].

In accordance with the laws of the Russian Federation, within the limits of their competence, the courts determine the compliance of the behavior of citizens, foreigners, and stateless persons within the country's territory with their legally established rights and freedoms, as well as the measures of responsibility and punishment for their violation.

The highest judicial body of constitutional review in Russia is the Constitutional Court of the Russian Federation, which, in accordance with Article 125 of the Constitution of the Russian Federation, exercises judicial power through constitutional proceedings in order to protect the foundations of the constitutional order, the fundamental rights and freedoms of man and citizen, and to ensure the supremacy and direct effect of the Constitution of the Russian Federation [1]. For example, the Constitutional Court of the Russian Federation, having considered the request of a group of deputies of the State Duma of the Federal Assembly of the Russian Federation, adopted a resolution recognizing the decree of the President of Russia of October 28, 1992 "On measures to protect the constitutional order of the Russian Federation" as inconsistent with the Constitution of the Russian Federation [14]. By this decision, the Constitutional Court of the Russian Federation prevented the possibility of violating the rights and freedoms of citizens of our country, which could have arisen as a result of arbitrary interpretations of the terms "terrorism" and "extremism", which at that time had no legal definition in Russian legislation, and were used in the discussed decree of the President of Russia [14].

In their activities, courts interact with supervisory and law enforcement agencies of the state, the structure of which is divided into branches, federal, regional and local levels.

Along with the state's obligation to ensure the protection of human and civil rights and freedoms, the Constitution of the Russian Federation grants individuals the opportunity to independently defend (self-defense) their rights and freedoms by all means not prohibited by law. Methods of self-defense are varied, including appealing the actions of officials to public authorities, including the courts, appealing to the media, human rights organizations, and others.

According to Part 2 of Article 55 of the Constitution of the Russian Federation, the state must not issue laws that abolish or diminish the rights and freedoms of man and citizen [1].

In the system of law enforcement agencies, the police is distinguished, the duties and powers of which to ensure the rights and freedoms of man and citizen are formulated in Article 5 of the Federal Law of 07.02.2011 No. 3-FZ "On the Police" (hereinafter referred to as the Law), called "Observance and respect for the rights and freedoms of man and citizen" [15].

In particular, paragraph 1 of the said article sets out one of the basic principles of police activity: “The police carry out its activities on the basis of compliance with and respect for the rights and freedoms of man and citizen” [13].

Particular attention should be paid to paragraph 2 of the aforementioned article of the Law, which requires that "police activities that restrict the rights and freedoms of citizens shall be immediately terminated if the legitimate objective has been achieved or it has become clear that this objective cannot or should not be achieved by restricting the rights and freedoms of citizens" [15]. Obviously, this provision of the Law is aimed at strict adherence to guarantees for ensuring the rights and freedoms of man and citizen in our country.

The following paragraphs of the article contain indications of restrictions on the actions of police officers in relations with citizens: “A police officer is prohibited from resorting to torture, violence, or other cruel or degrading treatment. A police officer is obliged to prevent actions that intentionally cause pain, physical or moral suffering to a citizen” [15].

Clause 6 of Article 5 of the Law prohibits the provision to anyone without the voluntary consent of the citizen, with the exception of cases stipulated by federal law, of information obtained as a result of police activity about the private life of a citizen [15]. At the same time, "... the police are obliged to ensure that every citizen has the opportunity to become familiar with

documents and materials that directly affect his rights and freedoms, unless otherwise established by federal law" [15].

Similar regulations are included in the documents regulating the activities of the prosecutor's office and other law enforcement agencies of the Russian Federation [13, 16].

In order to protect violated human and civil rights in the Russian Federation, specialized law enforcement institutions have been created: the Commissioner for Human Rights [17], the Commissioner for Children's Rights [18], the Commissioner for the Protection of the Rights of Entrepreneurs in the Russian Federation [19], which are called upon to consider citizens' appeals, complaints with reports of violated rights and freedoms, to seek their restoration and the prevention of illegal actions.

Part 3 of Article 46 of the Constitution of the Russian Federation grants everyone the right to international protection, which includes the ability to appeal to interstate bodies established to protect human rights and freedoms in accordance with the relevant international treaties of the Russian Federation.[1] Therefore, bodies within the law enforcement system of the Russian Federation, within the limits of their powers defined by federal legislation, implement guarantees to assist citizens in the realization and protection of their constitutional rights and freedoms.

At the same time, the culture of the peoples of Russia traditionally develops ethical norms and rituals of interaction, regulated by ethnic self-government bodies and supported by civil society institutions. Therefore, government bodies authorized by the state to ensure human and civil rights and freedoms in the Russian Federation are obligated to cooperate with civil society institutions that uphold the traditions of public diplomacy, which contribute to the prevention and resolution of social conflicts arising from disputes over the rights and freedoms of different people to satisfy their interests through a single object, the claims to which simultaneously become the subject of conflict between opposing parties.

Conclusion. The Russian Federation has established a system of human and civil rights and freedoms, the content of which has a specific historical character, determined by the dominant culture, worldview, and legislation in society. This system of human and civil rights and freedoms includes traditional norms of natural law, which provide stability to its structure, and norms of social relations, which are subject to change by the ruling political elites and acquire a temporary, situational nature, thereby generating systemic mobility.

The legal basis of the system of human and civil rights and freedoms in Russia consists of the Constitution of the Russian Federation, Russian legislation, relevant international legal acts insofar as they do not contradict the Russian Constitution, as well as generally accepted ethical norms.

In addition, in the regions of the Russian Federation, when developing and implementing measures aimed at ensuring the constitutional rights and freedoms of man and citizen, the traditions of public diplomacy must be taken into account, which contribute to the establishment of peaceful, mutually beneficial relations between people, taking into account the observance of the rights and freedoms of each of them.

In the Russian Federation, the guarantors of human and civil rights and freedoms are the President of Russia, other public authorities, state bodies, and public associations authorized to perform law enforcement and human rights functions. Clearly, the main focus of their activities should be fostering public understanding of the principles of peaceful coexistence among Russian citizens and fair treatment of their rights and freedoms.

Список источников

1. Конституция Российской Федерации (принята всенародным голосованием 12.12.1993 с изменениями, одобренными в ходе общероссийского голосования 01.07.2020). [Электронный ресурс]. URL: https://www.consultant.ru/document/cons_doc_law_28399/
2. Даль В.И. Толковый словарь русского языка. Современная версия. М.: ЗАО Изд-во ЭКСМО-Пресс, 2000. 736 с.
3. Ожегов С.И. Словарь русского языка: Ок. 57000 слов / Под ред. чл.-корр. АН СССР Н.Ю. Шведовой. 20-е изд., стереотип. М.: Рус. яз., 1988. 750 с.
4. Нерсесянц В.С. Философия права. М.: ИНФРА-М: Норма, *1997*. 652 с.
5. Платон. Полное собрание сочинений в одном томе. М.: Изд-во АЛЬФА-КНИГА, 2016. 1311 с.
6. Философский энциклопедический словарь / Редкол.: С.С. Аверинцев, Э.А. Араб-Оглы, Л.Ф. Ильичев и др. 2-е изд. М.: Сов. энциклопедия, 1989. 815 с.
7. Новейший философский словарь / Под ред. А.А. Грицанова. Минск: Изд. В.Н. Скакун, 1998. 896 с.
8. Страницы истории: почему СССР не поддержал проект декларации о правах человека? [Электронный ресурс]. URL: https://news.un.org/ru/audio/ 2016/ 12/1038451.
9. Всеобщая декларация прав человека. Принята резолюцией 217 А (III) Генеральной Ассамблеи ООН от 10 декабря 1948 года. [Электронный ресурс]. URL: https://www.un.org/ru/documents/decl_conv/declarations/declhr.shtml
10. О Декларации прав и свобод человека и гражданина: постановлением Верховного Совета РСФСР от 22.11.1991 № 1920-1. [Электронный ресурс]. URL: https://www.consultant.ru/document/cons.doc_LAW_3788/
11. По делу о проверке конституционности положений статьи 1 Федерального закона "О ратификации конвенции о защите прав человека и основных свобод и протоколов к ней", пунктов 1 и 2 статьи 32 Федерального закона "О международных договорах Российской Федерации", частей первой и четвертой статьи 11, пункта 4 части четвертой статьи 392 Гражданского процессуального кодекса Российской Федерации, частей 1 и 4 статьи 13, пункта 4 части 3 статьи 311 Арбитражного процессуального кодекса Российской Федерации, частей 1 и 4 статьи 15, пункта 4 части 1 статьи 350 Кодекса административного судопроизводства российской федерации и пункта 2 части четвертой статьи 413 Уголовно-процессуального кодекса Российской Федерации в связи с запросом группы депутатов Государственной Думы: Постановление Конституционного Суда РФ от 14.07.2015 № 21-П. [Электронный ресурс]. URL: https://www.consultant.ru/ document/cons_doc_LAW_182936/
12. Путин заявил, что РФ не отказывается от принципов всеобщей декларации прав человека. [Электронный ресурс]. URL: https://www.interfax. ru/russia/934624
13. Правоохранительные органы: курс лекций и учебно-методические материалы / Под ред. Ю.А. Лукичева. СПб.: Астерион, 2020.
14. По делу о проверке конституционности Указа Президента Российской Федерации от 28 октября 1992 года "О мерах по защите конституционного строя Российской Федерации»: Постановление Конституционного Суда РФ от 12 февраля 1993 г. № 3-П. [Электронный ресурс]. URL: https://www.consultant.ru/document/ cons_doc_law_6082/
15. О полиции: федерал. закон от 07.02.2011 № 3-ФЗ [Электронный ресурс]. URL: https://www.consultant.ru/document/ cons_doc_LAW_110165/
16. О прокуратуре Российской Федерации: федерал. закон от 17.01.1992 № 2202-1. [Электронный ресурс]. URL: https://www.consultant.ru/document/cons_doc_LAW_262/
17. Об Уполномоченном по правам человека в Российской Федерации: федер. конст. закон от 26.02.1997 № 1-ФКЗ [Электронный ресурс]. URL: https://www.consultant.ru/document/cons_doc_LAW_13440/
18. Об уполномоченных по правам ребенка в Российской Федерации: федер. закон от 27.12.2018 № 501-ФЗ. [Электронный ресурс]. URL: https://www.consultant.ru/document/ cons_doc_law_314643/
19. Об уполномоченных по защите прав предпринимателей в Российской Федерации: федер. закон от 07.05.2013 №78-ФЗ. [Электронный ресурс]. URL: https://www.consultant.ru/document/ cons_doc_law_145997/
20. О судебной системе Российской Федерации: федер. конст. закон от 31.12.1996 № 1-ФКЗ. [Электронный ресурс]. URL: https://www.consultant.ru/document/cons_doc_law_12834/

References

1. Konstitutsiya Rossiiskoi Federatsii (prinyata vsenarodnym golosovaniem 12.12.1993 s izmeneniyami, odobrennymi v khode obshcherossiiskogo golosovaniya 01.07.2020). [Ehlektronnyi resurs]. URL: https://www.consultant.ru/document/cons_doc_law_28399/
2. Dal' V.I. Tolkovyi slovar' russkogo yazyka. Sovremennaya versiya. M.: ZAO Izd-vo EHKSMO-Press, 2000. 736 s.
3. Ozhegov S.I. Slovar' russkogo yazyka: Ok. 57000 slov / Pod red. chl.-korr. AN SSSR N.YU. Shvedovoi. 20-e izd., stereotip. M.: Rus. yaz., 1988. 750 s.
4. Nersesyants V.S. Filosofiya prava. M.: INFRA-M: Norma, 1997. 652 c.
5. Platon. Polnoe sobranie sochinenii v odnom tome. M.: Izd-vo AL'FA-KNIGA, 2016. 1311 s.
6. Filosofskii ehntsiklopedicheskii slovar' / Redkol.: S.S. Averintsev, EH.A. Arab-Ogly, L.F. Il'ichev i dr. 2-e izd. M.: Sov. ehntsiklopediya, 1989. 815 s.
7. Noveishii filosofskii slovar' / Pod red. A.A. Gritsanova. Minsk: Izd. V.N. Skakun, 1998. 896 s.
8. Stranitsy istorii: pochemu SSSR ne podderzhal proekt deklaratsii o pravakh cheloveka? [Ehlektronnyi resurs]. URL: https://news.un.org/ru/audio/ 2016/ 12/1038451.
9. Vseobshchaya deklaratsiya prav cheloveka. Prinyata rezolyutsiei 217 A (III) General'noi Assamblei OON ot 10 dekabrya 1948 goda. [Ehlektronnyi resurs]. URL: https://www.un. org/ru/documents/decl_conv/declarations/declhr.shtml
10. O Deklaratsii prav i svobod cheloveka i grazhdanina: postanovleniem Verkhovnogo Soveta RSFSR ot 22.11.1991 № 1920-1. [Ehlektronnyi resurs]. URL: https://www.consultant.ru/ document/cons.doc_LAW_3788/
11. Po delu o proverke konstitutsionnosti polozhenii stat'i 1 Federal'nogo zakona "O ratifikatsii konventsii o zashchite prav cheloveka i osnovnykh svobod i protokolov k nei", punktov 1 i 2 stat'i 32 Federal'nogo zakona "O mezhdunarodnykh dogovorakh Rossiiskoi Federatsii", chastei pervoi i chetvertoi stat'i 11, punkta 4 chasti chetvertoi stat'i 392 Grazhdanskogo protsessual'nogo kodeksa Rossiiskoi Federatsii, chastei 1 i 4 stat'i 13, punkta 4 chasti 3 stat'i 311 Arbitrazhnogo protsessual'nogo kodeksa Rossiiskoi Federatsii, chastei 1 i 4 stat'i 15, punkta 4 chasti 1 stat'i 350 Kodeksa administrativnogo sudoproizvodstva rossiiskoi federatsii i punkta 2 chasti chetvertoi stat'i 413 Ugolovno-protsessual'nogo kodeksa Rossiiskoi Federatsii v svyazi s zaprosom gruppy deputatov Gosudarstvennoi Dumy: Postanovlenie Konstitutsionnogo Suda RF ot 14.07.2015 № 21-P. [Ehlektronnyi resurs]. URL: https://www.consultant.ru/ document/cons_doc_LAW_182936/
12. Putin zayavil, chto RF ne otkazyvaetsya ot printsipov vseobshchei deklaratsii prav cheloveka. [Ehlektronnyi resurs]. URL: https://www.interfax. ru/russia/934624
13. Pravookhranitel'nye organy: kurs lektsii i uchebno-metodicheskie materialy / Pod red. YU.A. Lukicheva. SPb.: Asterion, 2020.
14. Po delu o proverke konstitutsionnosti Ukaza Prezidenta Rossiiskoi Federatsii ot 28 oktyabrya 1992 goda "O merakh po zashchite konstitutsionnogo stroya Rossiiskoi FederatsiI»: Postanovlenie Konstitutsionnogo Suda RF ot 12 fevralya 1993 g. № 3-P. [Ehlektronnyi resurs]. URL: https://www.consultant.ru/document/ cons_doc_law_6082/
15. O politsii: federal. zakon ot 07.02.2011 № 3-FZ [Ehlektronnyi resurs]. URL: https://www.consultant.ru/document/ cons_doc_LAW_110165/
16. O prokurature Rossiiskoi Federatsii: federal. zakon ot 17.01.1992 № 2202-1. [Ehlektronnyi resurs]. URL: https://www.consultant.ru/document/cons_doc_LAW_262/
17. Ob Upolnomochennom po pravam cheloveka v Rossiiskoi Federatsii: feder. konst. zakon ot 26.02.1997 № 1-FKZ [Ehlektronnyi resurs]. URL: https://www.consultant.ru/document/cons_doc_LAW_13440/
18. Ob upolnomochennykh po pravam rebenka v Rossiiskoi Federatsii: feder. zakon ot 27.12.2018 № 501-FZ. [Ehlektronnyi resurs]. URL: https://www.consultant.ru/document/ cons_doc_law_314643/
19. Ob upolnomochennykh po zashchite prav predprinimatelei v Rossiiskoi Federatsii: feder. zakon ot 07.05.2013 №78-FZ. [Ehlektronnyi resurs]. URL: https://www.consultant.ru/ document/ cons_doc_law_145997/
20. O sudebnoi sisteme Rossiiskoi Federatsii: feder. konst. zakon ot 31.12.1996 № 1-FKZ. [Ehlektronnyi resurs]. URL: https://www.consultant.ru/document/cons_doc_law_12834/

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Конфликт интересов: автор заявляет об отсутствии конфликта интересов

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Критическая элитология: методологические основы и актуальные вопросы развития

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Аннотация. ***Введение.*** В статье рассмотрена критическая элитология представляющая собой раздел большой элитологии, который занимается вопросами верификации элитологического знания, установление достоверности элитности (благодаря которой субъект называется элитой), и экспертизой профессиональной достаточности в профессиональной деятельности элитных сообществ. Сама элитология понимается как комплексная дисциплина о сущности феномена элиты и элитности в их историческом развитии. И как показывает опыт, не всегда суждения об элите отвечают научным нормам. Как известно, критика всегда подразумевает разбор, обсуждение кого - или чего-либо с целью оценить достоинства и выявить недостатки. По отношению к элитологии ее критическая часть выполняет роль внутреннего инквизитора (следователя). Критический подход дисциплинирует и приучает к внимательному и более ответственному отношению к информации. ***Цель*** работы – проанализировать место и роль критической элитологии в системе элитологического знания. ***Материалы и методы.*** В статье использованы системный подход, историографический анализ последних элитологических исследований. ***Результаты и обсуждение.*** Отмечено, что элитологические ценности меняются в зависимости от исторической эпохи и нуждаются в постоянном диалектическом сопровождении. Особое внимание уделено вопросам верификации и разоблачению фальсификации. Рассмотрены некоторые актуальные аспекты практической деятельности критической элитологии. ***Заключение*** Подчёркнута роль культурной элиты особенно в условиях развития цифровых технологий и искусственного интеллекта последнего времени.

Ключевые слова: элитология; критика; феномен элиты и элитности; методология; верификация; фальсификация; политический карнавал; актуальные проблемы.
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Research article

Critical elithology: methodological foundations and current issues of development

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Abstract. ***Introduction***. Critical elitology is a branch of large elitology that deals with the verification of elitological knowledge, the establishment of the authenticity of elitism (which makes an individual an elite), and the examination of professional sufficiency in the professional activities of elite communities. Elitology itself is understood as a comprehensive discipline about the essence of the phenomenon of the elite and elitism in their historical development. As experience shows, not all judgments about the elite meet scientific standards. As is well known, criticism always implies an analysis, discussion of someone or something in order to evaluate the merits and identify the shortcomings. In relation to elitology, its critical part performs the role of an internal inquisitor (investigator). A critical approach disciplines and accustoms to a careful and more responsible attitude towards information. The purpose of the work is to analyze the place and role of critical elitology in the system of elitological knowledge. ***Materials and methods***. The article uses a systematic approach and a historiographical analysis of recent elitological studies. ***Results and discussion.*** It is noted that elitological values change depending on the historical era and require constant dialectical support. Special attention is paid to the issues of verification and exposure of falsification. Some relevant aspects of the practical activities of critical elitology are considered. ***Conclusion*** The role of the cultural elite is emphasized, especially in the context of recent developments in digital technologies and artificial intelligence.

Keywords: elitology; criticism; elite and elitism phenomenon; methodology; verification; falsification; political carnival; current issues

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Introduction.

From the history of science, we know that all classical theories eventually become outdated and conflict with new realities. The world is changing and demands that science keep pace with it, rather than drag it back into the past with its dogmas. The difference between the past and history is that the latter claims scientific truth, while the former claims objectivity. History is scientifically evaluative, while the past can contain both reliable and unreliable information.

Elitology is understood as a comprehensive, specialized science studying the phenomenon of elites and elitism. It is phenomenological in nature, characterized by both extreme generalizations and specific specificities. Critical elitology analyzes and judges the merits and demerits of elites, analyzing and evaluating their moral and professional activities. In relation to elitology itself, its critical component acts as an impartial judge, identifying and identifying errors and contradictions, providing analytical assessments, and verifying the reliability and authenticity of everything related to the phenomenon of elites/elitism. The elitologist is guided by the principle of «trust*, but verify* ," for "a healthy distrust is the path to productive collaboration."

Criticism means searching for the new within the existing old. And the key here is to adhere to the principle of Occam's razor: «Non *sunt entia multiplicanda praeter necessitatem* " (" *One should not multiply things unnecessarily* "). Constructive criticism allows for improvements where none are expected. Through it, hidden resources are activated and qualitative advances in scientific knowledge are achieved. This is precisely what critical elitology aims to achieve in its practical work.

Methodological foundations of critical elitology

Elitological notions are not objective and require constant correction by critical elitology. Therefore, the role of critical assessment and self-assessment is always important, especially when analyzing phenomena such as the elite and elitism. The task of critical elitology is to clarify the relevance of classical theories in an ever-changing reality and to reexamine the existing authority of classical theories. The key is to understand the dialectic of elite development, accurately determine the hermeneutic content of the information left by elites, and uncover elite symbolism and cultural-historical codes.

In critical elitology, we can distinguish two vectors of research: 1) *epistemological* —a critical analysis of elitological research; and 2) *ontological* —a critical analysis of the practices of the elites themselves. These directions define the very specificity of the scientific activity of elitological knowledge.

It's especially worth noting that the elite/elite phenomenon is historical, sociocultural, and professional in nature. Each profession has its own elite groups with their own sets of value assessments. This specialization leaves its mark on all elitological studies. Hence, the specific methodological approach required to analyze each professional group.

The methodological foundation of critical elitology is based on research methods such as dialectics, hermeneutics, comparative studies, semiotics, and historicism. This combination of methods ensures its independence, objectivity, and adequacy.

For example, *dialectics* allows us to identify the dynamics of the development of the elite and elitism, to establish the rhythms and characteristics of their development, and to identify existing contradictions between form (elite) and content (elitism). Dialectics refutes the elite's desire for institutionalized stability (staticity) and points to the constant changes occurring within and around it.

Hermeneutics reveals to elitology the hidden aspects of elite existence, the mode and character of their thought, helps to establish the quality of their intellectual potential, and reveal the cultural characteristics of their everyday and professional language. Historical elites (now a thing of the past) exist in the form of the historical texts they left behind. For elitology, it is crucial to objectively assess their quality during their lifetimes. For current elites, hermeneutics can be revealing, as it can reveal not only their obvious strengths but also their hidden flaws. Aiding dialectic, hermeneutics identifies the contradictions that exist within elites, thereby pointing to the dynamics of their development.

Comparative studies also plays a special role. Elites themselves are accustomed to constantly comparing themselves with others (especially with competitors). For them, comparison is an opportunity to showcase their qualities in a more favorable light and portray their enemies in a negative light. For critical elitology, comparative studies allows for the establishment of universal criteria for assessing elite quality, the development of a ranking of elites within the elites themselves, and the identification of distinctive features. As a complement to hermeneutics, the comparative method allows for the identification of similarities and differences between various texts that construct the character of specific elites or individual members.

Semiotics reveals the communicative connections and signs (symbols, images) that elite groups use in their communication. Each historical elite may have its own distinct set of symbols and codes that reflect their uniqueness. The same applies to the specifics of their professional specialization.

The principle *of historicism* seeks to establish certain historical patterns in the development of elites, describing their development through concepts such as elitogenesis, elitocracy, and elitocide. Elitological historicism presupposes an analysis of research objects in relation to the specific historical conditions of their existence. It strives for an adequate and objective disclosure of cultural codes and the establishment of algorithms by which professional elite communities exist and develop.

All this allows us to view the elite/elitism as a phenomenon that exerts a significant influence on history, culture, and social life. While classical elite theories focused primarily on sociopolitical elites, elitology focuses on the activities of professional elite communities and the specific characteristics of their elite qualities. This is precisely why elitology is more in need of critical assessment and increasingly subject to scientific verification procedures.

Critical elitology is not so much a critique ("destruction") of existing theories as it is an opportunity for their subsequent constructive correction and development. It is a rational identification of contradictions existing in both the theory and practice of elites. This is the path of elitological *maieutics,* which intelligently asks questions about the authenticity of elite existence and the qualitative validity of their elitism. To do this, it must critically examine elitism, revealing and proving its substantive component as truly unique and select. And if not for everyone, then at least for many. In short, critical elitology is the midwifery of greater elitology.

The current issues of critical elitology include such problems as: 1) establishing authorship and creating an objective portrait of a historical figure (personalism); 2) clarifying theoretical positions and relevance; 3) verifying falsification; 4) qualifying professional expertise (identifying the real professional level of an elite subject); 5) analyzing intra-elite discourse, recording disagreements in elitological research and the diversity of elitological experience; 6) identifying the causes of ethical violations in academic science and in professional elite practice (axiological analysis), etc. Let us now consider these problems in more detail.

Current issues in the development of critical elitology

Critical elitology focuses on refining classical theories of elites, adding to and correcting existing inaccuracies, discrepancies, and misconceptions. In this regard, critical elitology has always existed spontaneously, in the form of in-person and remote discussions on current elitological topics. In this paper, we merely summarize what already exists, attempting to identify some of its patterns.

Critical elitological personalism. To conduct a hermeneutic examination, it is necessary to initially understand the personality traits of the author of a text/speech. Establishing authorship and creating an objective portrait of a historical figure becomes a priority for critical elitology. World literature has seen instances of a work being authorless. For unknown reasons, an anonymous author may wish to remain anonymous. Such cases are not uncommon and can be explained by many factors. However, for hermeneutics, the absence of an author is an extremely undesirable situation, as it creates a shadow zone in the text being studied. Personalistic elitology pays particular attention to the motives of such historical figures. [3] It is precisely these motives that most often hold the answer to the question of why a subjective description of reality does not correspond to its objective reality.

Vague anonymity also arises when politicians publish texts written for them by their aides. Anonymity on the one hand (the public often doesn't know who actually writes politicians' official speeches) and hidden plagiarism on the other (the politician publicly presents someone else's work as their own) further confuse the situation.

Clarification of theoretical propositions and relevance. As noted above, classical theories tend to become outdated, which deepens their disconnect with reality. Critical elitology represents a necessary "mechanism" for the constant refinement and correction of existing theories, testing their relevance and validity.

Classical elite theories (G. Mosca, V. Pareto, R. Michels) were developed in the early 20th century, amidst the conditions of developed imperialism (colonialism), mass political

movements (the so-called "revolt of the masses"), world war, and so on. They reflected the cultural codes of their time and expressed the values and ideals that existed at the time. The realities of the 21st century are different. Both the changes that have occurred in the world and the transformations taking place today force us to reassess and understand classical theories. The most significant change was the emergence, in the late 20th century, of a comprehensive science (elitology), which no longer studies individual elite groups but rather comprehensively explores the phenomenon of elites/elitism.

Verification of falsification. Control over information has always been and remains the most important professional attribute of the elite. Elites always claim to possess the truth, but they either distribute it sparingly to the masses or conceal it entirely from the public. Elites (especially political ones) always strive to appear better in history than they actually were. It is for this reason that political falsifications proliferate throughout history and give rise to various myths and legends. Critical elitology engages in various political exposés. It exposes both the false praise of the supposed virtues of supposedly "great politicians" and the crises that arise from the erroneous actions of unpopular politicians. Political history shows that elites have a pathological fear of the truth. Crimes stemming from these crimes fill the political history of such elites. They envy those who are better than them. *The elite sit as the best of the best.* But not all who enter the elite achieve this state.

Professional qualification assessment. Determining the true professional level of an elite subject is a crucial step in establishing elite identity. It is a kind of "litmus test" that reveals whether this subject or elite group is a genuine or a sham elite. In the elite/elite phenomenon, there is always a split between the genuine and the sham elite. The quasi-elite is a dark shadow that constantly looms over the genuine elite. And quite often, the public perceives something as elite that is not actually one.

It is well known from world history that political elites constantly require confirmation of the effectiveness of their public administration. [8] The personnel composition of political elites, in particular, is constantly changing. "Entry and exit" from elite groups is often accompanied by serious political crises. And professional quality is not always the determining factor in selection. If, in practice, elites prove incapable of determining the true quality of candidates for leadership positions, then critical elitology becomes the last "fortress" that can tell the truth about this personnel manipulation. Closely related to this topic is another problem – the problem of elite selection.

The problem of adequate elite selection. Critical elitology is concerned with expert assessment of the professional competence of elite subjects, and the extent to which they act professionally. A low level of competence always raises suspicions that the subject is in the wrong place (their personal merits do not correspond to their high status). The main source of elite selection is the University and higher professional elite education. [12]

Elite education plays a significant role in addressing this issue, as the fundamental mechanism for selecting the very best personal qualities and creating a truly elite persona. At the same time, the problems of negative elite selection are clearly manifested and analyzed within the framework of carnival political culture. Political carnival is the ultimate manifestation of elite decadence, their systemic decline, and moral corruption. For carnival elites, the institution of reputation is dead, and they no longer need it. For such elites, selection itself is unimportant, and the very fact of being among the elite is paradoxical.

The problem of negative elite selection brings elitology research directly to the topic of political carnival and carnival political culture. [6] Political carnival is understood as a kind of elite deviation, a collection of anecdotal incidents, a provocation, and a scandal. [See: 9; 18] It is a world of special (spoiled) relationships, which by their very nature demonstrate to everyone what elites should never be. Political carnival is a denial of the very existence of the elite, since it is entirely based on fakes, imitation, and pseudo-reality. It is a quasi-world, a pseudo-reality in

which false elites and their false political leaders exist. But for critical elitology, a negative example is also of particular importance, since it demonstrates the antithesis of the elite.

Intra-elite discourse. The analysis of intra-elite discourse involves documenting emerging disagreements in elitological research, as well as analyzing the diversity of elitological experience, which constantly emerges from objective reality. As historiographical experience shows, there is not always unity in the academic community in assessing the qualities of elites. This largely reflects the diversity existing within the elites themselves. Unity of opinion is a sign of ideological dogmatism, not scientific objectivity. The point here is to prevent extreme opinions, assessments, and conclusions from leading to the destruction of the very foundations of elitology. A dialectical approach, on the contrary, welcomes the presence of contradictions and their constructive resolution.

Axiological Analysis. Critical elitology faces the task of promptly identifying the causes of ethical violations in academic science and in professional elite practice. All this points to the need for a prompt axiological analysis of the existing professional practices of elites and their leaders. Elites (especially political ones) too often cross the ethical threshold and find themselves on the other side of good and evil. It is precisely these kinds of cases that should become a special subject of study for critical elitology. The topic of ethics is one of the central themes for greater elitology. It is always relevant for all professional elite communities. In addition, critical elitology faces the task of exposing *the political pathology* of ruling elites. As is well known, pathology studies disease processes and conditions in a living organism. Pathology is a deviation that causes suffering both to the elites themselves and to those they govern. The extreme form of this elitist pathology is "rabies," manifested in various types of phobias, especially photophobia. At the root of all this lies envy, which becomes the basis for all the crimes of such elites. The image of "political rage" perfectly fits the carnival-like political elites. [See: 6; 9]

Combating the "witch hunt." Critical elitology also combats the elitist prejudices that influence the opinions of elitologists and introduce distortions into the corresponding scientific picture of the world. These include the demonization of political enemies, various phobias (such as the Russophobia of modern Western elites), the personality cult of the leader, class egocentrism (which asserts the select culture of some and the insignificance of others), and so on. In the practices of political elites, the idealization of some (their own) and the demonization of others (theirs) is the norm in the struggle for power. In the context of digitalization, this struggle acquires new features and new characteristics. [13] And critical elitology must promptly propose new techniques that could mitigate these new threats of distortion (falsification) of political reality.

General questions. Critical elitology calls for avoiding extremes in judging elites, i.e., one cannot blindly and unconditionally trust elites, just as one cannot deny everything that comes from them. An extreme position insists that elites (especially political ones!) should never be trusted at all. This essentially nihilistic position, somewhat tantamount to conspiracy theory, does not stand up to elitological criticism, since it denies elites the right to speak the truth. Such extremes should be avoided.

Critical elitology also points to vulnerabilities in the development of scholarship on the phenomenon of the elite/elite. Using historiography, it reveals areas of theoretical development where gaps exist or where the greatest number of questions and unresolved issues accumulate. One such problematic area is the interaction between political and cultural elitology. The role of the cultural elite manifests itself in the development of not only art and science, but also in the construction of the foundations of empires. [2] And it is precisely this issue that has not received its due theoretical development. Another such "weakness" is personalistic elitology.

The topic of personality is one of the central themes in humanitarian elitology. This is particularly true for questions related to the analysis of such categories as "perfection," "ideal," "cultural elitism," and "creativity." [See: 10-11] It is through these theories that elitology reveals the characteristics of elite culture and the activities of elite cultural individuals. [See: 16-17] Cultural elitology explores the world of the creatively active and elite-productive individual.

This is precisely why it requires methods such as hermeneutics and semiotics, since without them, the personalistic aspect of the elite/elite phenomenon will simply be closed to this type of research. [See: 4] The motives for the behavior of such individuals will be unclear without a detailed examination of their individual characteristics.

There is a danger that artificial intelligence could give rise to a similarly artificial elite. The very word "artificial" suggests a counterfeit (surrogate) for the real (genuine). [1] The topic of falsification does not arise in this context by chance, but is a logical continuation. In the future, elites will increasingly face the problem of falsification. In the context of accelerated processes, this will lead to a shortage of time for verification. The latter will limit the critical verification of information, which automatically generates a wave of errors and new fakes. [15] Politicians will become increasingly dependent on PR strategies based on the use of AI, which could give rise to a new kind of "enslavement." [14]

In the digital age, the question of the elite's new professional identity [5] and changes in the quality of their professional training are becoming increasingly pressing, as are transformations in their worldview and thinking. [7] Digital society is developing a new system of relationships (demands) for its new digital elites. And these demands increasingly conform to the criteria of meritocracy. Therefore, when faced with the moral choice between oligarchy and meritocracy, elitology will always favor the latter.

Conclusion

The methodological foundations and key current issues of critical elitology we have examined allow us to draw some preliminary conclusions. First, we note that critical elitology performs a crucial verification function related to establishing the truth about the elite and its phenomenological qualities (elitism). For the academic community, it is crucially important whether it is dealing with an elite or a counterfeit version of it. The answer to this fundamental question largely determines the credibility of subsequent answers to other (clarifying) questions.

Secondly, critical elitology exposes ethical violations in the professional activities of elite communities. It is precisely ethics that most often falls outside the purview of academic elitology. Elitologists (especially political ones) are extremely reluctant to address this topic, which is in fact fundamental to the elite. But there is so much speculation and manipulation surrounding all this that any elitological study always risks escalating into a political scandal with highly uncertain consequences.

Finally, critical elitology engages in a comprehensive study of political pathology, as defined by the deviant behavior of ruling elite groups. This experience allows not only to critically expose the negative aspects of ruling elites but also to prevent such elements from coming to power. Thus, critical elitology precedes elitological engineering, which is concerned with the creation of new breeding models. The future will largely depend on such projects to establish solid foundations for meritocratic elites and relegate oligarchic structures to the distant past.

Список источников

1. Алексеева, И. Искусственный интеллект и искусственная элита. Вопросы элитологии. 2025. 6(3) С. 12-29.
2. Гайнутдинова Е.В. Роль культурной элиты в поисках самобытного пути к развитию идеологических основ Российской Империи. Вопросы элитологии. 2021. 2(4)С.10-21.
3. Гайнутдинова Е.В. Мотивационные стратегии современной элиты в новых реалиях самобытного пути развития России. Вопросы элитологии. Т.4. №1. 2023. С.24-36. doi: 10.46539/elit.v4i1.13
4. Глазков А. П. Духовное развитие и теологичность элитарности. Вопросы элитологии. 2020. Том 1. №2. С.65-74.
5. Дрягалов В. Идентичность цифровых элит в условиях новых вызовов информационно–технологической эпохи. Вопросы элитологии. 2025. 6(3), С.182-193.
6. Карабущенко П.Л. Карнавальная политическая культура: системный анализ основных категорий. Вопросы элитологии. Том 1. №2, 2020. С.31-62.

7. Карабущенко Н., Карабущенко П.Л. Информационно-экономическая и международная безопасность России: перспективы подготовки кадров для элиты. Вопросы элитологии. 2025. 6(3). С.120-138.
8. Косов Г., Половцев О. Концепция типологизации ряда проблем публичного управления и возможности их проектного решения в эпоху тотальной цифровизации. Вопросы элитологии. 2025. 6(3). С. 63-74.
9. Оськина О.И. Евразийские и европейские элиты в зеркале карнавальной политической культуры. Вопросы элитологии. 2023. Т.4. №4 (16). С.13-25, doi: 10.46539/elit.v4i4.17
10. Подвойский Л.Я. Элитологические воззрения А.Ф. Лосева: эстетика совершенства. Вопросы элитологии. 2023. Т.4. №2. С.105-117, doi: 10.46539/elit.v4i1.15
11. Подвойский Л.Я. А. А. Тахо-Годи – духовная дочь А.Ф. Лосева (к 101-летию со дня рождения). Вопросы элитологии. 2023. 4(3), С. 145-162.
12. Резаков Р.Г. Современная элитология образования: элитное vs элитарное? – Рецензия на статью О.В. Крыштановской & И. А. Лавровой (2023) «Высшее образование в России: элитное vs элитарное?» Мир России, 32(4), 138-159. Вопросы элитологии. 2023. 4(4). С.103-107.
13. Романцова М. Проблемы формирования политических элит в эпоху развития цифрового общества. Вопросы элитологии. 2025. 6(3). С.156-169.
14. Тризно Т. Трансформация политической коммуникации и роль ИИ в PR-стратегиях при формировании образа политических элит. Вопросы элитологии. 2025. 6(3). С.100-119.
15. Федоров, А. Искусственный интеллект и дезинформация. Вопросы элитологии2025. *6*(3). С.30-51.
16. Хлыщева Е.В. Метамодерн как новое мировидение: синтез массового и элитарного. Вопросы элитологии. 2021. Т.2. №2. С.10-21.Doi: h,ps://doi.org/10.465139/elit.v2i2.60
17. Хлыщева Е.В. Культура отмены как инструмент политической элиты. - Вопросы элитологии. Т.4. №1. 2023. С.13- 23. doi: 10.46539/elit.v4i1.134
18. Шебзухова Т.А. Политический исторический анекдот в системе карнавальной политической культуры. Вопросы элитологии. 2022. Т.3. №4 . С.13-25. doi: 10.46539/elit.v3i4.12

References

1. Alekseeva, I. Iskusstvennyi intellekt i iskusstvennaya ehlita. Voprosy ehlitologii. 2025. 6(3) S. 12-29.
2. Gainutdinova E.V. Rol' kul'turnoi ehlity v poiskakh samobytnogo puti k razvitiyu ideologicheskikh osnov Rossiiskoi Imperii. Voprosy ehlitologii. 2021. 2(4)S.10-21.
3. Gainutdinova E.V. Motivatsionnye strategii sovremennoi ehlity v novykh realiyakh samobytnogo puti razvitiya Rossii. Voprosy ehlitologii. T.4. №1. 2023. S.24-36. doi: 10.46539/elit.v4i1.13
4. Glazkov A. P. Dukhovnoe razvitie i teologichnost' ehlitarnosti. Voprosy ehlitologii. 2020. Tom 1. №2. S.65-74.
5. Dryagalov V. Identichnost' tsifrovykh ehlit v usloviyakh novykh vyzovov informatsionnO–tekhnologicheskoi ehpokhi. Voprosy ehlitologii. 2025. 6(3), S.182-193.
6. Karabushchenko P.L. Karnaval'naya politicheskaya kul'tura: sistemnyi analiz osnovnykh kategorii. Voprosy ehlitologii. Tom 1. №2, 2020. S.31-62.
7. Karabushchenko N., Karabushchenko P.L. Informatsionno-ehkonomicheskaya i mezhdunarodnaya bezopasnost' Rossii: perspektivy podgotovki kadrov dlya ehlity. Voprosy ehlitologii. 2025. 6(3). S.120-138.
8. Kosov G., Polovtsev O. Kontseptsiya tipologizatsii ryada problem publichnogo upravleniya i vozmozhnosti ikh proektnogo resheniya v ehpokhu total'noi tsifrovizatsii. Voprosy ehlitologii. 2025. 6(3). S. 63-74.
9. Os'kina O.I. Evraziiskie i evropeiskie ehlity v zerkale karnaval'noi politicheskoi kul'tury. Voprosy ehlitologii. 2023. T.4. №4 (16). S.13-25, doi: 10.46539/elit.v4i4.17
10. Podvoiskii L.YA. Ehlitologicheskie vozzreniya A.F. Loseva: ehstetika sovershenstva. Voprosy ehlitologii. 2023. T.4. №2. S.105-117, doi: 10.46539/elit.v4i1.15
11. Podvoiskii L.YA. A. A. Takho-Godi – dukhovnaya doch' A.F. Loseva (k 101-letiyu so dnya rozhdeniya). Voprosy ehlitologii. 2023. 4(3), S. 145-162.
12. Rezakov R.G. Sovremennaya ehlitologiya obrazovaniya: ehlitnoe vs ehlitarnoe? – Retsenziya na stat'yu O.V. Kryshtanovskoi & I. A. Lavrovoi (2023) «Vysshee obrazovanie v Rossii: ehlitnoe vs ehlitarnoe?» Mir Rossii, 32(4), 138-159. Voprosy ehlitologii. 2023. 4(4). S.103-107.

13. Romantsova M. Problemy formirovaniya politicheskikh ehlit v ehpokhu razvitiya tsifrovogo obshchestva. Voprosy ehlitologii. 2025. 6(3). S.156-169.
14. Trizno T. Transformatsiya politicheskoi kommunikatsii i rol' II v PR-strategiyakh pri formirovanii obraza politicheskikh ehlit. Voprosy ehlitologii. 2025. 6(3). S.100-119.
15. Fedorov, A. Iskusstvennyi intellekt i dezinformatsiya. Voprosy ehlitologii2025. 6(3). S.30-51.
16. Khlyshcheva E.V. Metamodern kak novoe mirovidenie: sintez massovogo i ehlitarnogo. Voprosy ehlitologii. 2021. T.2. №2. S.10-21.Doi: h,ps://doi.org/10.465139/elit.v2i2.60
17. Khlyshcheva E.V. Kul'tura otmeny kak instrument politicheskoi ehlity. - Voprosy ehlitologii. T.4. №1. 2023. S.13- 23. doi: 10.46539/elit.v4i1.134
18. Shebzukhova T.A. Politicheskii istoricheskii anekdot v sisteme karnaval'noi politicheskoi kul'tury. Voprosy ehlitologii. 2022. T.3. №4 . S.13-25. doi: 10.46539/elit.v3i4.12

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Современное теоретико-методологическое прочтение политических категорий «Элитарии» и «Элитариум»

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Аннотация. ***Введение.*** В статье проводится концептуальный анализ и дается авторское определение термина «элитарий» (élitaire), который активно используется в публицистике и научной литературе, но не имеет четкого терминологического значения. ***Материалы и методы.*** Автор предлагает понимать элитария как представителя слоя, близкого к элите, но не являющегося ею: это лицо с элитарными наклонностями и потенциалом, которое, однако, не обладает достаточным авторитетом, ответственностью и известностью, чтобы считаться полноценной элитой. ***Результаты и обсуждение.*** Введена система классификации («субъект элиты», «человек элиты», «личность элиты») для более точного описания стратификации внутри элитных групп. Раскрыта роль элитариев как «и.о. элиты» в условиях кризиса традиционных элит, исследует понятие «элитариум» как символическое пространство функционирования элит и проводит различие между политическим и культурным элитариумами. ***Заключение.*** На основании проведенного исследования можно сделать вывод, что подмена истинной элиты элитариями является ключевой характеристикой современного политического кризиса.

Ключевые слова: Элитарий (élitaire), элитология, политическая элита, элитариум, протоэлита, субъект элиты, человек элиты, личность элиты, кризис элит, истеблишмент, меритократия, псевдоэлита, политическое закулисье, культурная элита.

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Research article

Modern theoretical and methodological interpretation of the political categories "Elite" and "Elite"

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Abstract. ***Introduction.*** The article provides a conceptual analysis and the author's definition of the term "elite", which is actively used in journalism and scientific literature, but does not have a clear terminological meaning. ***Materials and methods.*** The author suggests understanding an elitist as a representative of a stratum close to the elite, but not one of them: this is a person with elite inclinations and potential, who, however, does not have enough authority, responsibility and fame to be considered a full-fledged elite. ***Results and discussion.*** A classification system is introduced ("elite subject", "elite person", "elite personality") to more accurately describe the stratification within elite groups. The role of elitarians as "acting elites" in the context of the crisis of traditional elites is revealed, and the concept of "elitarium" is explored as a symbolic space for the functioning of elites, with a distinction made between political and cultural elitariums. ***Conclusion.*** Based on the conducted research, it can be concluded that the substitution of the true elite by the elitists is a key characteristic of the current political crisis.
Key words: Elite, elitism, political elite, elitium, proto-elite, elite subject, elite person, elite personality, elite crisis, establishment, meritocracy, pseudo-elite, political backstage, cultural elite.
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Introduction. The current stage of development in socio-political science is characterized by an active search for and refinement of conceptual frameworks capable of adequately reflecting an increasingly complex social reality. One of the key areas requiring conceptual clarity is elitology, which studies the structure, mechanisms of formation, and transformation of elite groups in society. Recently, the term "élitaire" has become firmly established in scholarly and journalistic discourse. Despite its frequent use, it remains vague and has not received universal academic recognition. Its spontaneous use to describe a wide range of phenomena—from the elite's inner circle to marginalized individuals aspiring to elite status—creates terminological confusion and complicates scholarly analysis.

For modern elitological science the clarification of this or that new term is of fundamental importance, then case emerging V scientific literature, or V Media. Sometimes introduced terms turn out to be unsuccessful and non-viable. Sometimes happen obvious terminological advances, and the new category accurately describes a specific objective reality. Therefore, we should also clarify which objective reality exactly reality describes term "élitaire" ("elitist/elitistries ")[5].

Materials and methods. The methodological basis of the study was a qualitative analysis of textual sources. The research materials included scientific publications on the problems of elitology, political science and sociology, materials of elitology congresses, encyclopedic publications, as well as journalistic works in which the analyzed term is actively used. The main methods of the work were: conceptual analysis, allowing to identify the semantic core and contexts of use of the term "elitist"; the comparative method applied to compare and differentiate related categories ("elite", "pseudo-elite", "proto-elite", "establishment"); the classification method used to construct a typology ("elite subject", "elite person", "elite personality"); as well as an institutional approach, which contributed to the understanding of the "elitarium" as a symbolic space and institution of elite functioning. The combination of these methods allowed for a comprehensive theoretical analysis and the author's interpretation of the political categories under consideration.

This concept is found in journalism and some scientific works,but it still hasn't received a clear terminological meaning. Therefore, we will take the liberty and responsibility of providing a preliminary description of this term.

Research results and their discussion. Judging by By context, term elitist is used For designations close to the elite, but still somewhat different from it, a layer of political and cultural figures [1; 3]. This is the elite's inner circle, a potential reserve of elite personnel, but still not quite the elite itself. Finally, the elites are the public that surrounds the elite and whose opinions (advice) the elite takes needs or pretends to be in need.[6, p . 112-128; 7, p . 96]

An elitist (élitaire) is a person with elitist tendencies, with elite aesthetic tastes and ethical views; bearer of elite cultural and professional values, endowed with elite abilities (certain professional skills), which pursuit (having potential) become an elite and who, when the opportunity arises, pretends to be an elite or takes a position some elite position (job title), but without proper grounds for it. What is not what it takes for an elitist to become an elite is authority, positive (constructive) fame, and the courage to take responsibility for being a real human being. (A Not subject) of the elite.

In this regard, we introduce three warrants for understanding the essence of the elite: (1) “elite subject”, (2) “elite person” and (3) “personality elites."

1. “Subject *elites”*: private nothing Not notable representativeelites, more often total imitating her presence, those. Direct analogue the concept of "elitist".

(2) “Elite *Man*”: an actively and independently acting representative of the elite, making responsible decisions and bearing personal responsibility for them responsibility; pro higher class.

(3) “Personality *elites”*: face, with which it is personified elite - leader, leader, guru (spiritual leader, classic).

In the general context of our article, we are talking specifically about the “subjects” of the elite, about elites.

The elitist does not live the full life of an elite man, he only exists and survives on the threshold of the elite; he only breathes the feeling of the advent of elite status. The uncertainty of his position (status) forces him to balance on the boundaries of the elite and pseudo-elite.

An elitist is someone who has access to elite values or resources possessed by the elite and who, by virtue of this, poses as an elite; a defective elite, an imitation of an elite; a situational subject of the elite. This classification applies falls under concept "establishment", and "intelligentsia". But V difference from them, the elite still strives for power and very often gets it. In contrast from them, elitist has opportunity to play in "acting" elite", but they hasn’t [4].

But an elite can also be a marginal person (in the past a wandering poet, philosopher, hermit), not included in any of the existing his time of elite groups, but by its nature - "elite man." History often classifies rear number to elite specific historical time such "radicals" falling out from existing classifications. Such elites Singles are the exception to the rule; they are the most positive example of how Even if you are not elite, you are still elite in spirit, in the degree of your personal dignity, by vocation.

In political practice, in the absence of a real (genuine) elite, the elites begin to play the role of the elite, i.e. to perform the functions of “acting elite” (G.K. Ashin), filling the resulting empty space. In the context of the global crisis of political elites, we see this everywhere today. Today there is no such a country in world where would be elites Not took top over the elite.

Elites transform V elites Then, When turn out to be helpless IN the chaos of the world and cannot cope with the challenges of their time. They show their bankruptcy, their helplessness, their disillusionment, and their indifference to what's happening. Eclecticism reigns in the elites' minds, and they find it difficult to establish a logical order in their thinking. From here all their spiritual qualities are mixed up values. Due to this deficiency, various values appear in science every now and then. Genus Job, discrediting concepts "elite" And "meritocracy" because they are not describing elites or meritocracy at all, but rather that “something” that is them accepted.

The elitists have always existed as a vague premonition of the emerging elites. The elite circle is always structurally unformed individuals with the potential and aspirations to be elite. Elites can unite into pressure groups and lobby for certain interests. But more often than not, this is a Browniana movement of individual people. As soon as they manage to organize themselves,

V their structure an early elite emerges. [7, p. 234]

Thus, *the elitists are not yet the elite, but they are no longer the masses* (simple ordinary person); this inferior, failed elites, proto-elites; a kind of "elite broth" from which the elite may one day be born. More often In general, the elites remain faceless and unknown “trash of history.” Having had the opportunity, but never realizing itself in history as a full-fledged and a self-sufficient historical figure.

Analysis political realities shows, What from Togo, Who before us Whether one is “elite” or “elite” depends on the specific point of view – so, for local population This will "elite", A For federal structures authorities - "elitist." Those above see shortcomings better than those below. From below, shortcomings may seem insignificant or even look like virtues. The opposition may even abuse criticism and demonize. Those who are not - on the contrary, it is beneficial for them that the elite looks like elite.

Elitarium is thus understood by us as the location of the elites in a specificpolitical space. Elitarium should also be understood as a club of elites, the place (or places) where they most often meet and interact. Each the political national elite has such symbolic places: in Russia - this is the Kremlin, V USA - White house And Congress, in Germany - Reichstag, in Great Britain – Parliament... This symbolism predetermines the ritual practices of the elites and forms a specific etiquette of their behavior. The existing ritual of the elites reveals their essence.

Conclusion. Thus in this way, elitarianism reflects essence political cultures their own countries. This Part spectacular political show, sometimes transforming into an outright farce and carnival of the great political space. And than the more comfortable the elites feel in this space, the more boldly they behave in their "political masquerade." The Elitarium is the place where all the elites – they wear their masks; backstage is that exclusive space where they do these things. Sometimes they take off their masks. If the elitism is open to elitological research, That V political behind the scenes access only by special passes.

In contrast to the political elitism, the elitism of cultural elites and cultural elites represents by yourself highly organized community creative minorities, V which are saved And are developing cultural values and assets designed to ensure the spiritual security of all humanity. This space also has its own "radicals" who throw a challenge to the entire society and seeking to disrupt and destroy the established bonds of this spiritual communication. In totalitarian systems, these two elitisms strive for complete fusion; in liberal systems, they find a way to coexist. Regardless Friend from friend. Exactly by ratio these spirit elite worlds we can judge by the kind of society we live in and what kind of political mode reigns in a specifically taken country.

An analysis of recent political realities shows that that it is precisely this kind of elite that is taken for the elite. Crisis the elite became possible in many ways due to the fact that the elites replaced themselves elite.

Список источников

1. Геворкян К. «Элитарии всех стран, соединяйтесь!» // Фонд Нораванк. [Электронный ресурс].URL: https://noravank.am/rus/issues/detail.php?ELEMENT_ID=3107 (Дата обращения: 24.07.2025).
2. Душа элитария. // PolitRussia. [Электронный ресурс]. URL: https://politrussia.com/politkasha/dusha-elitariya-508/ (Дата обращения: 15.07.2025).
3. Макашов В. «Элитарии» и «пролетарии» - идеология исключительности и комплекс низкой самооценки. // LiveJournal. - [Электронный ресурс]. URL: https://korobok12. livejournal.com/669188.html (Дата обращения: 20.07.2025)
4. Моллаев З. Х., Нелепов М. В. Поиски залежей УВ Восточного Ставрополья на основе концепции блокового строения осадочного чехла. Геология, геофизика и разработка нефтяных и газовых месторождений. 2004. № 7. С. 21–22.
5. Российская элитология: инновационные ответы на вызовы современного мира: материалы Третьего Всероссийского элитологического конгресса с международным участием 15-16 февраля 2019 г., Ростов-на-Дону. Ред.-изд. гр.: А.Ю. Шутов (руков.), О.В. Локота, А.В.

Понеделков и др. Изд-во ЮРИУ РАНХиГС, 2019. Т.1. 480с.; Т.2. 468с.
6. Нелепов М. В., Томашев Д. В., Папоротная А. А. Оценка влияния трещиноватости коллекторов на эффективность проведения геолого-технических мероприятий в продуктивных отложениях Восточного Ставрополья. Нефтепромысловое дело. 2019. № 7 (607). С. 28–33. https://doi.org/10.30713/0207-2351-2019-7(607)-28-32
7. Элитология России: современное состояние и перспективы развития: материалы Первого Всероссийского элитологического конгресса с международным участием, 7-8.10.2013 г. Ростов-на-Дону. Ред.-из. В.В. Рудой (руков.) и др. Ростов н/Д.: Изд-во ЮРИФ РАНХиГС, 2013. Т.1. 928с.; Т.2. 832с.; Т.3. Донское книжное издательство, 420с.
8. Элитология: Энциклопедический словарь. /Под ред. проф. П.Л. Карабущенко. М.: Экон-информ, 2013. 618 с.
9. Элиты и лидеры: стратегии формирования в современном университете. Материалы международного конгресса. 19-22 апреля 2017 г. / Под редакцией проф. А.П. Лунева и проф. П.Л. Карабущенко. Астрахань: Издательский дом «Астраханский университет». 2017. 364с.
10. Hayes, Christopher. Twilight of the Elites: America After Meritocracy. Crown Pub- lishing Group (NY), 2012. – 304p.

References

1. Gevorkyan K. «Ehlitarii vsekh stran, soedinyaites'!» // Fond Noravank. [Ehlektronnyi resurs].URL: https://noravank.am/rus/issues/detail.php?ELEMENT_ID=3107 (Data obrashcheniya: 24.07.2025).
2. Dusha ehlitariya. // PolitRussia. [Ehlektronnyi resurs]. URL: https://politrussia.com/politkasha/dusha-elitariya-508/ (Data obrashcheniya: 15.07.2025).
3. Makashov V. «EhlitariI» i «proletariI» - ideologiya isklyuchitel'nosti i kompleks nizkoi samootsenki. // LiveJournal. - [Ehlektronnyi resurs]. URL: https://korobok12. livejournal.com/669188.html (Data obrashcheniya: 20.07.2025)
4. Mollaev Z. KH., Nelepov M. V. Poiski zalezhei UV Vostochnogo Stavropol'ya na osnove kontseptsii blokovogo stroeniya osadochnogo chekhla. Geologiya, geofizika i razrabotka neftyanykh i gazovykh mestorozhdenii. 2004. № 7. S. 21–22.
5. Rossiiskaya ehlitologiya: innovatsionnye otvety na vyzovy sovremennogo mira: materialy Tret'ego Vserossiiskogo ehlitologicheskogo kongressa s mezhdunarodnym uchastiem 15-16 fevralya 2019 g., Rostov-na-Donu. Red.-izd. gr.: A.YU. Shutov (rukov.), O.V. Lokota, A.V. Ponedelkov i dr. Izd-vo YURIU RANKhIGS, 2019. T.1. 480s.; T.2. 468s.
6. Nelepov M. V., Tomashev D. V., Paporotnaya A. A. Otsenka vliyaniya treshchinovatosti kollektorov na ehffektivnost' provedeniya geologo-tekhnicheskikh meropriyatii v produktivnykh otlozheniyakh Vostochnogo Stavropol'ya. Neftepromyslovoe delo. 2019. № 7 (607). S. 28–33. https://doi.org/10.30713/0207-2351-2019-7(607)-28-32
7. Ehlitologiya Rossii: sovremennoe sostoyanie i perspektivy razvitiya: materialy Pervogo Vserossiiskogo ehlitologicheskogo kongressa s mezhdunarodnym uchastiem, 7-8.10.2013 g. Rostov-na-Donu. Red.-iz. V.V. Rudoi (rukov.) i dr. Rostov n/D.: Izd-vo YURIF RANKhIGS, 2013. T.1. 928s.; T.2. 832s.; T.3. Donskoe knizhnoe izdatel'stvo, 420s.
8. Ehlitologiya: Ehntsiklopedicheskii slovar'. /Pod red. prof. P.L. Karabushchenko. M.: Ehkon-inform, 2013. 618 s.
9. Ehlity i lidery: strategii formirovaniya v sovremennom universitete. Materialy mezhdunarodnogo kongressa. 19-22 aprelya 2017 g. / Pod redaktsiei prof. A.P. Luneva i prof. P.L. Karabushchenko. Astrakhan': Izdatel'skii dom «Astrakhanskii universiteT». 2017. 364s.
10. Hayes, Christopher. Twilight of the Elites: America After Meritocracy. Crown Pub- lishing Group (NY), 2012. – 304r.

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Торгово-экономическое взаимодействие России и Таиланда: от стагнации к потенциалу роста в формате ЕАЭС

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Аннотация. ***Введение.*** Российско-таиландские торговые отношения развиваются волнообразно, оставаясь значительно ниже потенциальных возможностей. ***Цель.*** Выделить ключевые фазы развития и барьеры в двусторонней торговле в период 2010–2024 гг. и определить пути интенсификации сотрудничества в формате ЕАЭС. ***Материалы и методы.*** Исследование построено на анализе статистики внешней торговли России и Таиланда, институциональной базы двустороннего сотрудничества и динамики переговоров по созданию ЗСТ между ЕАЭС и Таиландом. ***Результаты и обсуждение.*** Выявлены периоды роста (начало 2010-х), спада (после 2014 г.), стагнации (2022–2024 гг.) и системные барьеры: отсутствие ЗСТ, слабая логистика и маргинальная доля РФ в торговле Таиланда (<0,3%). Структура торговли взаимодополняющая: сырьё из России против готовой продукции из Таиланда. ***Заключение.*** Заключение ЗСТ между ЕАЭС и Таиландом является ключевым инструментом для вывода торговли на новый уровень, диверсификации товарооборота и реализации потенциала «Большого евразийского партнёрства».
Ключевые слова: Евразийский экономический союз (ЕАЭС), зона свободной торговли (ЗСТ), Россия–Таиланд, торгово-экономическое сотрудничество, внешняя торговля, диверсификация, логистика, геополитика.
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Research article

Trade and Economic Interaction between Russia and Thailand: From Stagnation to Growth Potential within the EAEU Framework

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Abstract. ***Introduction***. Russian-Thai trade relations have developed in waves and remain well below their potential. ***Goal.*** To identify key phases of development and barriers in bilateral trade in the period 2010–2024 and determine ways to intensify cooperation within the EAEU framework. ***Materials and methods.*** The study is based on an analysis of Russia and Thailand's foreign trade statistics, the institutional framework of bilateral cooperation, and the dynamics of negotiations on establishing an FTA between the EAEU and Thailand. ***Results and discussion.*** Periods of growth (early 2010s), decline (after 2014), and stagnation (2022–2024) were identified, as well as systemic barriers: absence of an FTA, weak logistics, and Russia's marginal share in Thailand's trade (<0.3%). The trade structure is complementary: raw materials from Russia vs. finished goods from Thailand. ***Conclusion.*** Concluding an FTA between the EAEU and Thailand is a key instrument for bringing trade to a new level, diversifying trade turnover, and realizing the potential of the "Greater Eurasian Partnership".
Key words: Eurasian Economic Union (EAEU), Free Trade Agreement (FTA), Russia–Thailand, trade and economic cooperation, foreign trade, diversification, logistics, geopolitics.

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Введение. Российско-таиландские отношения, несмотря на дружественный характер и развивающееся политическое сотрудничество, демонстрируют нереализованный торгово-экономический потенциал. За последние 15 лет товарооборот не отличался стабильностью, находясь под сильным влиянием внешнеполитических событий, глобальных кризисов и структурных ограничений. В период с 2010 по 2024 год Россия так и не вошла в число ключевых торговых партнеров Таиланда, занимая лишь 36–38 позицию с долей менее 0,3%. При этом существующие двусторонние институты и декларируемые намерения сторон указывают на обоюдную заинтересованность в активизации связей. На фоне «поворота на Восток» российской внешней политики и стремления Таиланда к диверсификации внешнеэкономических связей особую актуальность приобретает анализ причин стагнации и поиск практических механизмов

перехода к устойчивому росту, ключевым из которых является создание зоны свободной торговли (ЗСТ) в формате Евразийского экономического союза (ЕАЭС).

Материалы и методы исследований. Исследование носит комбинированный характер, сочетая качественные и количественные методы. Основу работы составил анализ динамики товарооборота между Россией и Таиландом, а также между странами-членами ЕАЭС и Таиландом за период 2010–2024 годов. Данные были получены из официальных источников: Федеральной таможенной службы РФ, Банка Таиланда, Евразийской экономической комиссии и Министерства торговли Таиланда. Вторым блоком стал институциональный анализ двусторонних и многосторонних соглашений, работы межправительственных комиссий и хода переговоров по ЗСТ ЕАЭС–Таиланд. Для оценки факторов влияния и выработки рекомендаций использовались методы сравнительного анализа, SWOT и PESTLE-анализ. Текстовые материалы включают официальные документы, доклады и экспертные оценки, опубликованные на русском, английском и тайском языках.

Результаты исследований и их обсуждение. Краеугольным камнем российско-таиландских отношений является принцип взаимного уважения, что отразилось на качестве двусторонних отношений между Москвой и Бангкоком. [1] Сегодня, обе страны объединяют десятки межгосударственных соглашений, которые затрагивают чувствительные направления сотрудничества в военной сфере, в области политики и экономики. Сохраняется положительная динамика встреч на высшем уровне.

Вместе с тем стоит отметить, что в июле 2023 года состоялось открытие Генерального консульства России на острове Пхукет. [2] Это первое подобное представительство в Таиланде. С учетом геополитической турбулентности, которая еще больше дестабилизировалась в 2022 году, указанное событие отражает особый доверительный статус российско-таиландских отношений.

В отдельный трек выделилось межпарламентское сотрудничество. На регулярной основе проводятся встречи между представителями Совета Федерации Российской Федерации и Национальной ассамблеи Королевства Таиланд. Встречи придают стимул укреплению диалога между народами государств.

На этом фоне стоит отметить переговоры Председателя Всероссийской политической партии «Единая Россия» и Заместителя Председателя Совета Безопасности России Дмитрия Медведева с Председателем партии «Пыа Тай» Королевства Таиланд Пхетхонгтхан Чинават в июне 2024 года. Встреча состоялась во Владивостоке в формате «БРИКС и страны-партнеры» на площадке Международного межпартийного форума Единой России «Мировое большинство за многополярный мир». [3]

Итоги встречи показали стремление сторон к поиску новых моделей сотрудничества на пути к формированию единого пространства безопасности и процветания в Евразии. Стороны выразили готовность развивать двусторонние отношения Москвы и Бангкока и выразили надежду на дальнейшее сближение Таиланда с БРИКС. Стоит отметить, что 16 августа 2024 года Пхетхонгтхан Чинават заняла пост премьер-министра Таиланда, а с 1 января 2025 года Таиланд официально стал государством-партнером БРИКС.

Вместе с тем особое значение государства придают диалогу в рамках многосторонних институтов. В своей Концепции внешней политики Россия [4] отмечает необходимость углубления отношений с государствами и интеграционными объединениями Азиатско-Тихоокеанского региона (АТР). В АТР ставится задача всестороннего развития отношений с АСЕАН и АТЭС. Как известно, Таиланд, как одна из стран-основательниц, стоит у истоков формулирования асеаноцентричных принципов и механизмов взаимодействия в АТЭС. На полях указанных интеграционных объединений сложилась добрая традиция проведения двусторонних контактов руководителей государств России и Таиланда.

Помимо этого, государства ведут совместную работу в рамках ВАС, БРИКС, АСЕМ, СВМДА, АРФ, ДАС, СМОА плюс, диалога «Шангри-Ла» и др. Обе страны являются наблюдателями в ОИС.

Таким образом, современные российско-таиландские отношения развиваются в позитивном русле. Сотрудничество ведется как в двустороннем формате, так и в рамках различных международных объединений. По многим направлениям двустороннего диалога сохраняется положительная динамика взаимосотрудничества и открываются новые горизонты для углубления контактов. Остается потенциал на пути к закреплению всеобъемлющего диалога.

Общие горизонты торгово-экономического взаимодействия России и Таиланда

Российско-таиландское экономическое сотрудничество является важным элементом межгосударственного диалога. Стороны сохраняют взаимный интерес к развитию торговых отношений. Сегодня, торгово-экономическое сотрудничество России и Таиланда насчитывает десятки соглашений, которые основываются на Торговом соглашении, подписанном в декабре 1970 года. [5]

На современном этапе действует Смешанная Российско-Таиландская комиссия по двустороннему сотрудничеству. В рамках Комиссии ведут работу подкомиссии и рабочие группы по различному спектру торгово-экономического сотрудничества между государствами. Активно взаимодействуют соответствующие министерства, особенно в области энергетики и сельского хозяйства. Вместе с тем ведется сотрудничество в частном секторе, где ведут свою работу Российско-Таиландский и Таиландско-Российский деловые советы. В то же время, в Таиланде функционирует российское Торговое представительство [6].

Для справки, в апреле 2023 года в Бангкоке состоялось восьмое заседания Смешанной Российско-Таиландской комиссии по двустороннему сотрудничеству. [7]

В ходе мероприятия участники провели конструктивный диалог по широкому кругу актуальных тем, представляющих взаимную важность для обеих сторон. Обсуждение затронуло широкий спектр направлений (энергетика, экономика, торговля, климат, цифровизация, космос, сельское хозяйство др.). В рамках программы состоялась тематическая секция, посвященная перспективам партнерства в регионах Дальнего Востока и Арктической зоны Российской Федерации.

Были заключены межведомственные меморандумы о сотрудничестве в сфере физической культуры и спорта, а также в области изучения и мирного освоения космоса. Кроме того, между Корпорацией развития Дальнего Востока и Арктики и Таиландско-Российским Деловым советом было подписано Соглашение о взаимодействии.

С учетом вышеизложенного стоит отметить, что российско-таиландское экономическое сотрудничество динамично развивается в рамках межправительственных и деловых структур. Стороны активно взаимодействуют в ключевых отраслях, включая энергетику, сельское хозяйство и высокие технологии, а также расширяют региональное партнерство, включая Дальний Восток и Арктику. Подписание новых соглашений подтверждает взаимную заинтересованность в углублении двусторонних связей.

Таблица 1. Торговый оборот Россия-Таиланд в 2010-2024 гг. (составлено авторами) / Table 1. Russia-Thailand trade turnover in 2010-2024 (compiled by the authors)

Торговый оборот Россия-Таиланд 2010-2024 гг. (миллионов долларов США)					
Источники	**Год**	**Оборот**	**Экспорт**	**Импорт**	**События**
Таиландские источники	2024	1582,25	885,46	696,79	
	2023	1512,84	820,83	692,01	Февраль
	2022	1854,00	584,36	1269,64	
	2021	2288,0	494,2	1793,8	
Российские источники	2020	1774,6	353,9	1420,7	Ковид-19
	2019	2367,9	614,0	1753,9	
	2018	2609,3	753,5	1855,8	
	2017	2 229,6	512,1	1 717,6	
	2016	1761,8	615,1	1146,7	Выборы в США
	2015	2051,9	560,9	1491,1	Крым
	2014	3983,7	1751,9	2231,8	
	2013	3357,0	1272,9	2084,1	
	2012	3381,8	1410,8	1971,0	Выборы в России
	2011	4 107,2	2 126,1	1 981,1	
	2010	2 906,5	1 536,3	1 370,2	

Торговые отношения между Россией [8] и Таиландом [9] за последние 14 лет демонстрируют нестабильную динамику, находясь под значительным влиянием внешнеполитических и экономических факторов.

В начале анализируемого периода (2010–2011 гг.) наблюдался устойчивый рост товарооборота, достигший своего пика в 2011 году - 4,1 млрд долларов. Этот период характеризовался активным развитием двусторонних экономических связей и благоприятной конъюнктурой на мировых рынках. Однако уже в 2012–2013 гг. наметилась тенденция к постепенному снижению объемов торговли до 3,3–3,4 млрд долларов, что было связано с изменением экономической политики обеих стран.

Знаковым стал 2014 год, когда на фоне украинского кризиса и введения западных санкций против России товарооборот резко сократился до 2,2 млрд долларов. Последующие три года (2015–2017) подтвердили устойчивость этой негативной тенденции - объемы торговли колебались в диапазоне 1,7–2,3 млрд долларов, что свидетельствовало о серьезном кризисе в двусторонних экономических отношениях.

Неожиданный рост до 2,6 млрд долларов в 2018 году сменился новым спадом в 2019–2020 гг., достигнув минимального значения в 1,7 млрд долларов в период пандемии COVID-19. Особенно сильно пострадал российский экспорт, сократившийся в 2020 году до рекордно низких 353,9 млн долларов.

Последние три года (2021–2024) демонстрируют попытки восстановления торговых связей. В 2021 году товарооборот вырос до 2,3 млрд долларов, а в 2022 - до 1,8 млрд, однако в 2023–2024 гг. вновь наметилось снижение до 1,5–1,6 млрд долларов. Примечательно, что структура торговли претерпела значительные изменения: если в 2010–2014 гг. Россия имела положительное сальдо торгового баланса, то в последующие годы ситуация кардинально изменилась в пользу Таиланда.

1) Период 2010–2014 гг.: Рост и стабилизация

- Относительная стабильность на мировых сырьевых рынках;
- Активизация работы Смешанной российско-таиландской комиссии;
- Рост туризма (в том числе как канал закупки тайских товаров);
- Подъём потребительского спроса на электронику и автотехнику из Таиланда в РФ.
- В этот же период Россия сохраняла положительное сальдо торгового баланса за счёт активного экспорта угля, нефти, удобрений и металлов.

2) Период 2014–2016 гг.: Геополитический обвал

- Санкционное давление и падение курса рубля;
- Утечка капитала и снижение инвестиций;
- Рост политических рисков, что повлияло на логистику и банковские операции;
- Частичный отказ тайских компаний от обслуживания российских клиентов из-за риска «вторичных санкций».
- Ситуация осложнилась снижением мировых цен на сырьевые товары, что критически сказалось на экспортных возможностях России.

3) Период 2017–2019 гг.: Этап частичного восстановления

- Переориентации РФ на азиатские рынки (в том числе в рамках «поворота на Восток»);
- Снижению волатильности на сырьевых рынках;
- Росту туристических потоков (в частности, медицинский и семейный туризм из РФ в Таиланд);
- Увеличению поставок техники и автокомпонентов из Таиланда.
- Тем не менее, устойчивого институционального прорыва не произошло - ЗСТ не была подписана, а барьеры сохранялись.

4) Период 2020–2021 гг.: Пандемия и логистический кризис

- Закрытие границ и прекращение пассажирского сообщения;
- Нарушение цепочек поставок;
- Рост фрахтовых ставок;
- Приостановка инвестиционных проектов;
- Пандемия продемонстрировала отсутствие гибких механизмов в логистике и зависимости от третьих стран (КНР, Сингапур) как транзитных звеньев.

5) Период 2022–2024 гг.: Геоэкономическая турбулентность и стагнация

- С 2022 года на фоне СВО и масштабного отключения России от западной финансовой системы (SWIFT, VISA, логистика) начался новый этап снижения.
- Уход международных перевозчиков с российского направления;
- Ограничения по расчётам в долларах;
- Осторожная позиция тайского бизнеса;
- Нестабильный курс рубля;
- Несмотря на негативный фон, в 2023–2024 гг. наблюдается рост сальдо в пользу России, что обусловлено восстановлением экспорта минеральных ресурсов и удобрений.

Таким образом, анализ показывает, что российско-таиландские торговые отношения отличаются высокой чувствительностью к внешнеполитическим кризисам и глобальным экономическим потрясениям. Несмотря на предпринимаемые усилия по диверсификации сотрудничества, объемы торговли так и не вернулись к докризисным показателям 2011–2014 годов, что требует разработки новых механизмов взаимодействия и поиска перспективных направлений экономического партнерства.

Таблица 2. ТН ВЭД между Россией и Таиландом (составлено авторами). / Table 2. HS between Russia and Thailand (compiled by the authors). [10]

Топ ТН ВЭД экспорт-импорт России				
№	Экспорт РФ		Импорт РФ	
	Код ТН ВЭД ЕАЭС	Сокращенное наименование товара, группы стран, страны	Код ТН ВЭД ЕАЭС	Сокращенное наименование товара, группы стран, страны
1	303	Рыба мороженая	8415	Установки для кондиционирования воздуха
2	511	Продукты животного происхождения прочие	8429	Дорожная и строительная техника
3	2701	Уголь каменный	8471	Вычислительные машины для автоматической обработки информации
4	2702	Лигнит (бурый уголь)	8703	Автомобили легковые
5	3105	Удобрения минеральные смешанные	8704	Автомобили грузовые
6	7207	Полуфабрикаты из нелегированной стали	8708	Части и принадлежности для автомобилей и тракторов
7	7224	Сталь, легированная в слитках	1604	Готовая или консервированная рыба, икра
8	7601	Алюминий необработанный	2008	Фрукты, орехи, приготовленные или консервированные иным способом
9	1001	Пшеница	4011	Шины
10	2701	Уголь каменный	8415	Установки для кондиционирования воздуха
11	2702	Лигнит (бурый уголь)	8429	Дорожная и строительная техника
12	2709	Нефть сырая, включая газовый конденсат	8471	Вычислительные машины для автоматической обработки информации
13	2710	Нефтепродукты	8517	Аппаратура связи и части к ней
14	3104	Удобрения калийные	8525	Аппаратура, передающая для радиовещания или телевидения
15	3105	Удобрения минеральные смешанные	8542	Электронные интегральные схемы
16	7207	Полуфабрикаты из нелегированной стали	8704	Автомобили грузовые
17	7207	Полуфабрикаты из нелегированной стали	8708	Части и принадлежности для автомобилей и тракторов

18	7601	Алюминий необработанный	9018	Приборы и устройства, применяемые в медицине

Товарооборот между Россией и Таиландом имеет четко выраженную товарную специализацию, отражающую конкурентные преимущества экономик обеих стран. Анализ данных по ТН ВЭД позволяет выделить следующие ключевые тенденции.

Российский экспорт в Таиланд характеризуется ярко выраженной сырьевой направленностью. Основными статьями экспорта являются:

1. **Энергоносители** - уголь каменный и бурый, сырая нефть и нефтепродукты, составляющие основу поставок;
2. **Металлы и изделия из них** - стальные полуфабрикаты, легированная сталь и необработанный алюминий;
3. **Сельхозпродукция** - мороженая рыба и продукты животного происхождения;
4. **Удобрения** - калийные и смешанные минеральные удобрения;
5. **Зерновые** – пшеница.

Импорт России из Таиланда имеет принципиально иную структуру с преобладанием готовой промышленной продукции:

1. **Автомобильная техника и комплектующие** - легковые и грузовые автомобили, запчасти;
2. **Электроника и оборудование** - климатическая техника, строительное оборудование, вычислительная техника, аппаратура связи;
3. **Потребительские товары** - рыбные консервы, переработанные фрукты и орехи, шины;
4. **Медицинское оборудование** - приборы и устройства медицинского назначения.

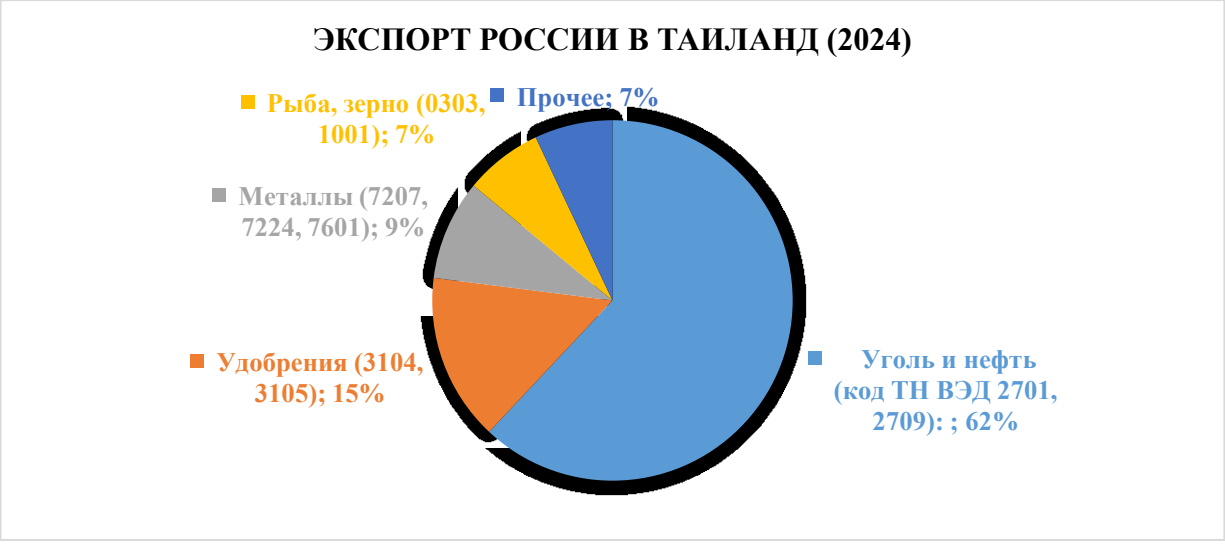

Рисунок 1. Экспорт России в Таиланд в рамках ТН ВЭД в 2024 году (составлено авторами). / Figure 1. Russian exports to Thailand under the HS in 2024 (compiled by the authors).

Рисунок 2. Импорт России из Таиланда в рамках ТН ВЭД в 2024 году (составлено авторами). / Figure 2. Russian imports from Thailand under the HS in 2024 (compiled by the authors).

Институциональные барьеры

Среди ключевых барьеров, ограничивающих торговлю между Россией и Таиландом:

- Отсутствие ЗСТ - базовая причина слабого доступа к рынку, где действуют высокие пошлины (до 30%) на российские товары.
- Сертификационные барьеры - сложности в признании российских технических и фитосанитарных стандартов.
- Непрозрачность таможенных процедур - необходимость взаимодействия с посредниками и брокерами.
- Слабое банковское сопровождение - отсутствие SWIFT у ряда российских банков, сложности с гарантиями.
- Малая институциональная представленность - недостаток специализированных торговых офисов, культурных центров, ВЭД-агентов.

Логистические ограничения

- Недостаточная развитость прямого морского сообщения между Владивостоком/Санкт-Петербургом и портами Таиланда (в частности, Лаем Чабанг).
- Зависимость от китайских хабов (Шэньчжэнь, Гуанчжоу, Сингапур) увеличивает сроки и стоимость поставок.
- Высокая стоимость фрахта: средняя стоимость доставки контейнера из России в Таиланд в 2024 году составляла 2900–3800 долларов.
- Нестабильность логистических цепочек - часто меняющиеся маршруты, простои на таможне.
- Ограниченность складской инфраструктуры в странах назначения.

Предложения по устранению барьеров

- Инициация переговоров по ЗСТ между ЕАЭС и Таиландом;
- Создание логистического коридора Владивосток - Порт Лаем Чабанг (через Вьетнам и Сингапур);
- Признание стандартов РФ в рамках ASEAN Single Window или отдельными соглашениями;
- Финансовая поддержка экспортеров в виде субсидирования логистики и сертификации;
- Расширение и активизация деятельности Торгового представительства России в Бангкоке, включая создание регионального офиса или бизнес-хаба в Восточном

экономическом коридоре (EEC, Паттайя - Районг - Чонбури). Это усилит институциональное присутствие РФ в Юго-Восточной Азии;

- Разработка цифровых платформ расчётов в рублях и батах;
- Систематическое участие российских компаний в региональных выставках, отраслевых форумах и кластерных программах ASEAN, что позволит повысить узнаваемость и доверие к российским товарам.

Для диверсификации товарооборота сторонам целесообразно развивать сотрудничество в следующих направлениях:

- Увеличение поставок российского продовольствия (рыба, зерно);
- Развитие промышленной кооперации в автомобилестроении;
- Сотрудничество в высокотехнологичных отраслях (медицинское оборудование, электроника);
- Создание совместных предприятий по переработке сырья.

Таким образом, структура товарооборота демонстрирует классическую схему взаимодействия сырьевой и индустриальной экономик. Россия поставляет в Таиланд преимущественно сырье и полуфабрикаты, получая взамен высокотехнологичную продукцию и товары народного потребления. Такая модель имеет как преимущества (гарантированный сбыт сырьевых товаров), так и недостатки (зависимость от конъюнктуры сырьевых рынков).

Таблицы 3. Место РФ во внешней торговле Таиланда в 2010-2024 гг. (составлено авторами). / Tables 3. Russia's place in Thailand's foreign trade in 2010-2024 (compiled by the authors).

Место РФ во внешней торговле Таиланда			
Год	Место России	Оборот (милл.долл.США)	События
2024	36	1,582.25	
2023	38	1,512.84	
2022	37	1,854.00	Февраль
2021	30	2,754.16	
2020	29	2,463.89	
2019	30	3,104.82	
2018	28	3,489.90	
2017	29	3,023.00	
2016	33	1,941.85	
2015	31	2,355.93	Крым
2014	23	4,913.63	
2013	24	4,693.33	
2012	21	5,189.01	
2011	21	5,668.50	
2010	21	3,995.84	

- Максимальные показатели сотрудничества пришлись на 2010-2014 годы;
- Геополитические события 2014 года нанесли серьезный удар по торговым отношениям;
- Частичное восстановление в 2017-2019 не вернуло прежних объемов;
- События февраля 2022 года ослабили позиции России во внешней торговле Таиланда.
- В современных условиях Россия занимает скромные 36-38 места среди торговых партнеров Таиланда;
- Текущий товарооборот в 3 раза ниже показателей 2011-2014 годов.

Анализ внешнеэкономических связей Королевства Таиланд за 2010–2024 годы показывает, что Россия занимает второстепенное положение в торговой структуре страны. Несмотря на потенциал сырьевой базы, статус постоянного члена Совбеза ООН и участие в интеграционных механизмах (БРИКС, ШОС, ЕАЭС), объёмы товарооборота между РФ и Таиландом не позволяют считать Россию приоритетным торговым партнёром для Бангкока.

По данным автора на основе статистики Банка Таиланда, место России среди торговых партнёров Таиланда на протяжении последних 15 лет имеет тенденцию к ухудшению.

В 2024 году Россия обеспечивала менее 0,3% от общего объема внешней торговли Таиланда (0,26% по расчетам автора на основе данных Bank of Thailand), в то время как Китай занимал позицию ведущего торгового партнёра с долей свыше 20%. Такая диспропорция подчёркивает маргинальное положение России в структуре внешнеэкономических связей Таиланда и указывает на неиспользованный потенциал двусторонней торговли.

Для сравнения стоит рассмотреть товарооборот России с другими государствами юго-восточной Азии:

Таблица 4. Торговый оборот России с некоторыми странами юго-восточной Азии за 2024 год (составлено атворами). / Table 4. Russia's trade turnover with some countries of Southeast Asia in 2024 (compiled by ATVs).

Страна	Товарооборот за 2024 (млрд. долл. США)
Вьетнам	5
Индонезия	4,3
Малайзия	3,5
Сингапур	4,5

В то же время, необходимо рассмотреть внешнюю торговлю Таиланда с ключевыми торговыми партнерами за 2024 год:

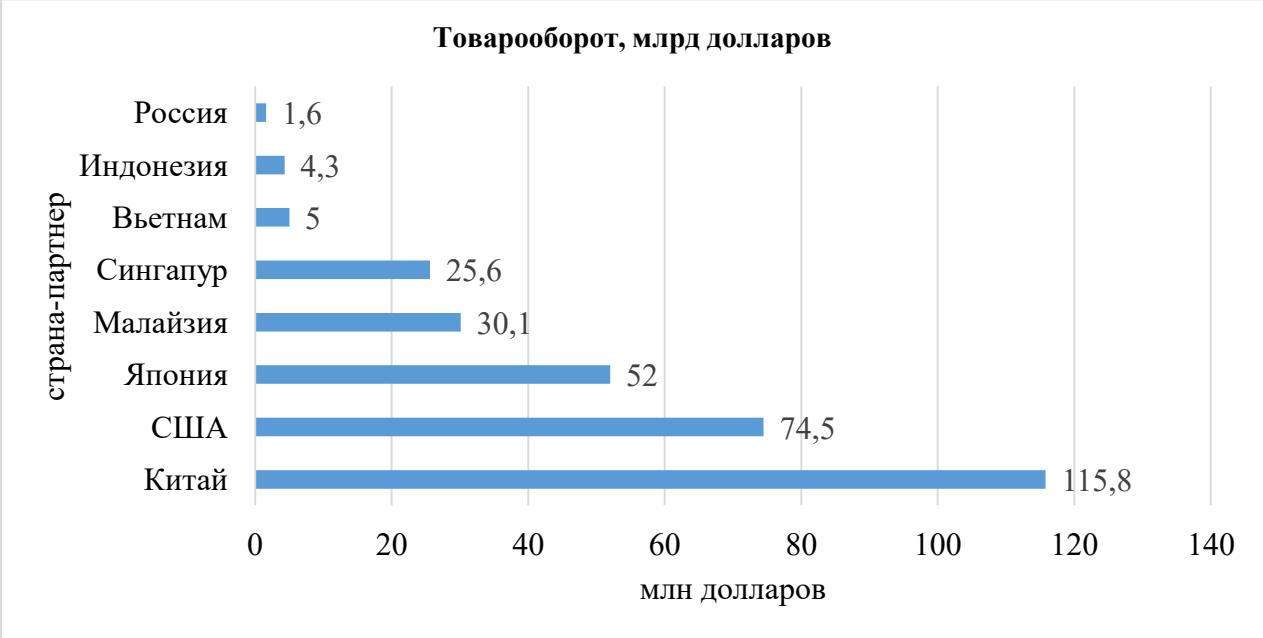

Рисунок 3. Торговый оборот Таиланда с ключевыми партнерами за 2024 год (составлено авторами). / Figure 3. Thailand's trade turnover with key partners in 2024 (compiled by the authors).

Одним из барьеров в развитии российско-таиландской торговли остаётся недостаточная узнаваемость и ограниченное восприятие российских товаров на тайском

рынке. По личному опыту автора, сопровождающего тайских предпринимателей в рамках внешнеэкономических сделок и бизнес-диалога, в Таиланде нередко отсутствует базовое представление о российской продукции. Тайские контрагенты зачастую задаются вопросом: «А что производится в России?», особенно когда речь идёт не о сырьевых, а о потребительских или промышленных товарах.

Это свидетельствует не столько о низком качестве продукции, сколько о недостатке целенаправленного продвижения российских товаров и брендов в Таиланде. На фоне активного маркетинга продукции из Японии, Южной Кореи и Китая, российские производители практически не представлены в торговых сетях, выставках и онлайн-платформах страны.

Проблему усугубляет и структура экспорта России: преобладание однородных сырьевых товаров (уголь, нефть, удобрения, металлы) затрудняет формирование комплексного и узнаваемого образа России как источника высокотехнологичной и потребительской продукции. В результате, Россия пока не воспринимается как значимый поставщик продукции с высокой добавленной стоимостью, что снижает потенциал торгово-промышленной кооперации с индустриально развитым Таиландом.

Факторы, препятствующие росту позиции России в торговом рейтинге Таиланда:

Географическая удалённость и слабая логистика:

- Отсутствие прямых морских и ж/д маршрутов;
- Неэффективная интеграция в цепочки поставок ЮВА.

Отсутствие ЗСТ:

- В отличие от Вьетнама, с которым действует ЗСТ с ЕАЭС, Россия торгует с Таиландом на менее выгодных условиях.

Недостаточная институциональная поддержка:

- Нет эффективных СП, бизнес-форумов, торговых представительств нового поколения.

Политические и санкционные риски:

- Таиландские банки и логистические операторы с осторожностью относятся к расчётам с российскими компаниями.

Таким образом, анализ российско-таиландских торговых отношений за 2010–2024 гг. выявляет их маргинальный характер: доля России во внешнеторговом обороте Таиланда не превышает 0,3%, демонстрируя тенденцию к снижению. Ключевые проблемы - слабая узнаваемость российских несырьевых товаров, отсутствие системного продвижения брендов и сырьевая структура экспорта РФ (уголь, нефть, металлы), что контрастирует с активностью азиатских конкурентов (Китай - 20% товарооборота). Несмотря на политическое взаимодействие в рамках БРИКС и ШОС, экономическое сотрудничество остаётся нереализованным потенциалом. Для роста товарооборота необходимы: диверсификация экспорта, агрессивный маркетинг высокотехнологичной продукции и участие в тайских торговых платформах. Без этих мер Россия рискует сохранить периферийную роль в экономике Таиланда.

Таблица 5. Торговый оборот по линии государств-членов ЕАЭС с Таиландом в 2015-2025 гг. (составлено авторами). / Table 5. Trade turnover between the EAEU Member States and Thailand in 2015-2025 (compiled by the authors).

THAI - Eurasian Economic Union (EAEU)	Million USD									
	Jan-Dec 2015	Jan-Dec 2016	Jan-Dec 2017	Jan-Dec 2018	Jan-Dec 2019	Jan-Dec 2020	Jan-Dec 2021	Jan-Dec 2022	Jan-Dec 2023	Jan-Dec 2024
Trade	2,490.54	2,065.75	3,210.82	3,690.89	3,265.98	2,580.21	2,993.21	2,097.10	1,781.41	1,942.02
Export	756.43	623.81	1,102.88	1,230.55	1,048.28	768.70	1,095.87	666.98	939.68	1,034.48
Import	1,734.11	1,441.94	2,107.94	2,460.34	2,217.70	1,811.51	1,897.33	1,430.12	841.73	907.54
Balance	-977.68	-818.13	-1,005.07	-1,229.79	-1,169.42	-1,042.82	-801.46	-763.13	97.95	126.94

Общая динамика товарооборота

За анализируемый период товарооборот демонстрировал нестабильную динамику:

- Пиковые значения зафиксированы в 2018 году (3,69 млрд долларов);
- Наибольший спад произошел в 2022-2023 годах (до 1,78-2,1 млрд);
- В 2024 году наметился небольшой рост до 1,94 млрд долларов.

Структура торговли

Торговый баланс на протяжении большей части периода был отрицательным:

- Максимальный дефицит (-1,23 млрд) зафиксирован в 2018 году;
- Перелом наступил в 2023 году, когда впервые зафиксирован профицит (+97,95 млн);
- В 2024 году положительное сальдо увеличилось до 126,94 млн долларов.

Экспортные показатели

- Наиболее успешный год - 2018 (1,23 млрд долларов);
- Серьезный спад в 2020-2022 годах (до 666,98 млн в 2022);
- В 2023-2024 годах - восстановление до 1,03 млрд долларов.

Импортные показатели

- Максимальные значения в 2017-2019 годах (2,1-2,46 млрд);
- Резкое сокращение в 2022-2023 годах (до 841,73 млн);
- В 2024 году - незначительный рост до 907,54 млн.

Ключевые периоды

- 2015-2016: Последствия кризиса 2014 года (низкие показатели);
- 2017-2019: Период относительной стабилизации;
- 2020-2022: Влияние пандемии и геополитических событий;
- 2023-2024: Перелом тенденции с появлением положительного сальдо.

Выводы:

1. Торговые отношения пережили несколько кризисных периодов.
2. В последние два года наметилась положительная динамика.
3. Изменение структуры торговли привело к появлению профицита.
4. Основной вызов - поддержание положительной динамики в условиях нестабильной международной обстановки.

В 2015 году Россия и Таиланд начали вести переговоры по формированию зоны свободной торговли в рамках ЕАЭС. Таиланд стал второй страной юго-восточной Азии, которая изъявила желание углублять сотрудничество с ЕАЭС (в мае 2015 года ЕАЭС подписал соглашение о зоне свободной торговли с Вьетнамом). [11]

Несмотря на наличие объективных институциональных, логистических и политических препятствий, в последние годы наблюдаются устойчивые предпосылки для заключения соглашения о зоне свободной торговли (ЗСТ) между ЕАЭС и Королевством Таиланд. Актуальность такого соглашения обусловлена как необходимостью диверсификации внешнеэкономических связей России в условиях геополитической переориентации, так и стремлением Таиланда расширить присутствие на евразийском рынке.

В 2018 году в Бангкоке между Евразийской экономической комиссией и Министерством торговли Таиланда был принят «Меморандум о сотрудничестве между Евразийской экономической комиссией и Правительством Королевства Таиланд» [12]. Документ затрагивал широкий спектр сотрудничества и был направлен на создание благоприятных условий. Была создана Совместная рабочая группа ЕЭК-Таиланд, которая должна была заседать не реже 1 раз в год.

Представители России и Таиланда проводят встречи различного уровня, в ходе которых ведут переговоры по поиску единой взаимовыгодной формулы для создания ЗСТ. В последние годы стороны обсуждают области сотрудничества в новых сферах, таких как сфера инфраструктуры, новых технологий, цифровизации и зеленой экономики [13]. Этот фактор говорит о стремлении сторон к скорейшему преодолению существующих барьеров и созданию общего экономического и торгового пространства.

Для справки, в ноябре 2024 года в Бангкоке состоялись переговоры заместителя главы МИД России Андрея Руденко с вице-министром иностранных дел Таиланда Рата Чаличана, в ходе которых Таиланд выразил готовность создать ЗСТ по линии ЕАЭС. Свою приверженность углублению диалога с ЕАЭС таиландская сторона подтвердила в рамках встречи главы МИД Таиланда Марит Сангиампхонг с российским коллегой Сергеем Лавровым на полях совещания министров иностранных дел БРИКС в Рио-де-Жанейро в апреле 2025 года.

Значимым событием стала встреча 29 мая 2025 года в рамках ЕЭК, где директор Департамента интеграции ЕЭК Микаел Беллуян и заместитель директора Европейского департамента МИД Таиланда Сомруди Пупорнанаке обсудили развитие двустороннего сотрудничества, включая перспективы ЗСТ. Таиланд подтвердил заинтересованность в изучении возможностей для создания зоны свободной торговли и выразил готовность к проведению третьего заседания Совместной рабочей группы, а также отраслевого семинара в июне 2025 года для обсуждения механизмов сближения стандартов и устранения барьеров в торговле [14].

Для сравнения, в январе 2025 года Таиланд заключил соглашение о ЗСТ с Европейской ассоциацией свободной торговли (ЕАСТ) - первым подобным соглашением с европейскими странами (Швейцария, Норвегия, Исландия, Лихтенштейн) [15]. Одновременно продолжаются переговоры с Европейским союзом, в рамках которых проведено пять раундов к марту 2025 года.

Помимо этого, Таиланд является участником двусторонних и многосторонних соглашений о свободной торговле с Китаем, Индией, Японией, Чили, Австралией, странами ASEAN, а также в рамках мегаинициативы RCEP. Такая стратегия подчёркивает системную направленность королевства на либерализацию торговли и региональную экономическую интеграцию.

Таким образом, переговоры с ЕАЭС выглядят закономерным продолжением внешнеэкономической политики Таиланда и представляют собой стратегическую возможность для России по расширению евразийских связей, в том числе с быстроразвивающимися странами Юго-Восточной Азии. В условиях санкционного давления, углубляющегося экономического партнерства с БРИКС и растущей роли альтернативных центров силы, подписание ЗСТ может существенно повысить значимость России на рынке АСЕАН.

Заключение ЗСТ позволит:

- устранить барьеры и снизить пошлины до 0–5%;
- стимулировать рост ВЭД малых и средних компаний;
- компенсировать частичную потерю рынков ЕС и G7;
- создать правовую предсказуемость для инвесторов;
- развивать кооперацию по моделям «сырьё → переработка → экспорт в третьи страны».

Среди ожидаемых выгод от соглашения можно выделить:

- увеличение экспорта продукции АПК, металлургии, химии, фармацевтики и машиностроения;
- доступ российских компаний к логистическим и производственным цепочкам в регионе ASEAN;
- повышение привлекательности Таиланда как хаба для реэкспорта и технологического обмена.

Для успешной реализации проекта ЗСТ необходимо:

- наличие политической воли и институциональной поддержки на высоком уровне;
- проведение детального анализа чувствительных секторов (сельское хозяйство, автомобили, цифровая продукция);
- создание рабочих групп по гармонизации технических регламентов и устранению нетарифных барьеров;
- обеспечение вовлечения бизнес-сообществ и экспортёров обеих стран в процесс консультаций.

Вместе с тем стоит отметить, что развитие политического и торгово-экономического сотрудничества России и Таиланда укрепит позиции России в АСЕАН и будет способствовать реализации концепции «Большого евразийского партнёрства», расширяя зону взаимовыгодного взаимодействия в Евразии. Углубление связей с Таиландом как ключевым игроком Юго-Восточной Азии также усилит российскую инициативу по формированию «Евразийской архитектуры безопасности», создавая альтернативные платформы многостороннего диалога. Это соответствует долгосрочным интересам России в Азиатско-Тихоокеанском регионе и открывает новые возможности для сотрудничества в рамках Россия–АСЕАН, включая торговлю, инвестиции и безопасность.

Заключение. Проведённый анализ внешнеэкономических связей между Россией и Таиландом выявил, что, несмотря на существующий потенциал, объёмы двусторонней торговли значительно отстают от реальных возможностей. Таиланд остаётся недоиспользованным экономическим партнёром России в регионе Юго-Восточной Азии, занимая в 2024 году лишь 36-е место среди её внешнеторговых контрагентов.

Товарооборот характеризуется волатильностью, зависящей от внешнеэкономической конъюнктуры и политической обстановки.

Структура торговли носит взаимодополняющий характер: РФ поставляет сырьё и полуфабрикаты, Таиланд - готовую продукцию.

Основные барьеры - институциональные (отсутствие ЗСТ, различия в стандартах), логистические (отсутствие прямого сообщения), а также регуляторные (таможня, банковская система).

Заключение ЗСТ между ЕАЭС и Таиландом представляется наиболее рациональным и экономически обоснованным шагом для вывода двусторонней торговли на качественно новый уровень.

Учитывая положительный опыт Вьетнама, заключившего соглашение с ЕАЭС, можно прогнозировать рост торговли с Таиландом при аналогичных условиях. Это особенно актуально в условиях глобальной переориентации внешнеэкономической стратегии России и укрепления связей с Азией.

Список источников

1. История отношений России и Таиланда. // Посольство России в Таиланде. URL: https://thailand.mid.ru/ru/countries/istoriya_otnosheniy/ (дата обращения: 31.08.2025).
2. Генеральное консульство Российской Федерации в г. Пхукете. URL: https://phuket.mid.ru/ (дата обращения: 31.08.2025).
3. Дмитрий Медведев провёл переговоры с Председателем партии «Пыа Тай» Королевства Таиланд Пхетхонгтхан Чинават. // Единая Россия. URL: https://er.ru/activity/news/dmitrij-medvedev-provel-peregovory-s-predsedatelem-partii-pya-taj-korolevstva-tailand-phethongthan-chinavat (дата обращения: 31.08.2025).
4. Концепция внешней политики Российской Федерации. // МИД России. URL: https://www.mid.ru/ru/detail-material-page/1860586/ (дата обращения: 31.08.2025).
5. Экономические связи России и Таиланда. // Посольство России в Таиланде. URL: https://thailand.mid.ru/ru/countries/ekonomicheskie_svyazi/ (дата обращения: 31.08.2025).
6. Торговое Представительство России в Таиланде. // Посольство России в Таиланде. URL: https://thailand.mid.ru/ru/embassy/torg_predstavitelstvo/ (дата обращения: 31.08.2025).
7. О проведении восьмого заседания Смешанной Российско-Таиландской комиссии по двустороннему сотрудничеству. // Посольство России в Таиланде. URL: https://thailand.mid.ru/ru/press-centre/news/o_provedenii_vosmogo_zasedaniya_smeshannoy_rossiysko_tailandskoy_komissii_po_dvustoronnemu_sotrudnich/ (дата обращения: 31.08.2025).
8. Федеральная таможенная служба. URL: https://customs.gov.ru/folder/511 (дата обращения: 31.08.2025).
9. Министерство торговли Таиланда. URL: https://tradereport.moc.go.th/en/stat/reportyear03 (дата обращения: 31.08.2025).
10. Евразийская экономическая комиссия. URL: https://eec.eaeunion.org/comission/department/dep_stat/tradestat/tables/extra/2021.php (дата обращения: 31.08.2025).
11. Таиланд может подать заявку на создание в ЕАЭС зоны свободной торговли. // Посольство России в Белоруссии. URL: https://belarus.mid.ru/ru/press-centre/news/tailand_mozhet_podat_zayavku_na_sozdanie_v_eaes_zony_svobodnoy_torgovli/ (дата обращения: 31.08.2025).
12. Меморандум о сотрудничестве между Евразийской экономической комиссией и Правительством Королевства Таиланд. // ЕАЭС. URL: https://docs.eaeunion.org/documents/165/3995/ (дата обращения: 31.08.2025).
13. ЕАЭС и Таиланд заинтересованы в развитии сотрудничества в сфере инфраструктуры, новых технологий, цифровизации и зеленой экономики. // ЕЭК. URL: https://eec.eaeunion.org/news/eaes-i-tailand-zainteresovany-v-razvitii-sotrudnichestva-v-sfere-infrastruktury-novyh-tehnologij-tsifrovizatsii-i-zelenoj-ekonomiki/ (дата обращения: 31.08.2025).
14. В ЕЭК обсудили сотрудничество ЕАЭС с Таиландом. // ОСФТС. URL: https://www.osfts.ru/novosti/2025/7122-v-eek-obsudili-sotrudnichestvo-eaes-s-tailandom (дата обращения: 31.08.2025).
15. ЗСТ между ЕАСТ и Таиландом. // ЕАСТ. URL: https://www.efta.int/trade-relations/free-trade-network/thailand (дата обращения: 31.08.2025).

References

1. Istoriya otnoshenii Rossii i Tailanda. // Posol'stvo Rossii v Tailande. URL: https://thailand.mid.ru/ru/countries/istoriya_otnosheniy/ (data obrashcheniya: 31.08.2025).
2. General'noe konsul'stvo Rossiiskoi Federatsii v g. Pkhukete. URL: https://phuket.mid.ru/ (data obrashcheniya: 31.08.2025).
3. Dmitrii Medvedev provel peregovory s Predsedatelem partii «Pya TaI» Korolevstva Tailand Pkhetkhongtkhan Chinavat. // Edinaya Rossiya. URL: https://er.ru/activity/news/dmitrij-medvedev-provel-peregovory-s-predsedatelem-partii-pya-taj-korolevstva-tailand-phethongthan-chinavat (data obrashcheniya: 31.08.2025).
4. Kontseptsiya vneshnei politiki Rossiiskoi Federatsii. // MID Rossii. URL: https://www.mid.ru/ru/detail-material-page/1860586/ (data obrashcheniya: 31.08.2025).

5. Ehkonomicheskie svyazi Rossii i Tailanda. // Posol'stvo Rossii v Tailande. URL: https://thailand.mid.ru/ru/countries/ekonomicheskie_svyazi/ (data obrashcheniya: 31.08.2025).
6. Torgovoe Predstavitel'stvo Rossii v Tailande. // Posol'stvo Rossii v Tailande. URL: https://thailand.mid.ru/ru/embassy/torg_predstavitelstvo/ (data obrashcheniya: 31.08.2025).
7. provedenii vos'mogo zasedaniya Smeshannoi Rossiisko-Tailandskoi komissii po dvustoronnemu sotrudnichestvu. // Posol'stvo Rossii v Tailande. URL: https://thailand.mid.ru/ru/press-centre/news/o_provedenii_vosmogo_zasedaniya_smeshannoy_rossiysko_tailandskoy_komissii_po_dvustoronnemu_sotrudnich/ (data obrashcheniya: 31.08.2025).
8. Federal'naya tamozhennaya sluzhba. URL: https://customs.gov.ru/folder/511 (data obrashcheniya: 31.08.2025).
9. Ministerstvo torgovli Tailanda. URL: https://tradereport.moc.go.th/en/stat/reportyear03 (data obrashcheniya: 31.08.2025).
10. Evraziiskaya ehkonomicheskaya komissiya. URL: https://eec.eaeunion.org/comission/department/dep_stat/tradestat/tables/extra/2021.php (data obrashcheniya: 31.08.2025).
11. Tailand mozhet podat' zayavku na sozdanie v EAEHS zony svobodnoi torgovli. // Posol'stvo Rossii v Belorussii. URL: https://belarus.mid.ru/ru/press-centre/news/tailand_mozhet_podat_zayavku_na_sozdanie_v_eaes_zony_svobodnoy_torgovli/ (data obrashcheniya: 31.08.2025).
12. Memorandum o sotrudnichestve mezhdu Evraziiskoi ehkonomicheskoi komissiei i Pravitel'stvom Korolevstva Tailand. // EAEHS. URL: https://docs.eaeunion.org/documents/165/3995/ (data obrashcheniya: 31.08.2025).
13. EAEHS i Tailand zainteresovany v razvitii sotrudnichestva v sfere infrastruktury, novykh tekhnologii, tsifrovizatsii i zelenoi ehkonomiki. // EEHK. URL: https://eec.eaeunion.org/news/eaes-i-tailand-zainteresovany-v-razvitii-sotrudnichestva-v-sfere-infrastruktury-novyh-tehnologij-tsifrovizatsii-i-zelenoj-ekonomiki/ (data obrashcheniya: 31.08.2025).
14. V EEHK obsudili sotrudnichestvo EAEHS s Tailandom. // OSFTS. URL: https://www.osfts.ru/novosti/2025/7122-v-eek-obsudili-sotrudnichestvo-eaes-s-tailandom (data obrashcheniya: 31.08.2025).
15. ZST mezhdu EAST i Tailandom. // EAST. URL: https://www.efta.int/trade-relations/free-trade-network/thailand (data obrashcheniya: 31.08.2025).

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Проблемы власти и государственности в исламской политико-правовой мысли

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Аннотация. ***Введение.*** В статье представлено описание эволюции концепций власти и государственности в исламской политико-правовой мысли от классического периода до современности, исследуется взаимосвязь религиозных доктрин с политической практикой мусульманского общества. ***Цель.*** Выделение проблем и перспектив развития исламской политико-правовой доктрины в контексте трансформации представлений о легитимности власти и формах государственного устройства. ***Материалы и методы.*** Исследование построено на анализе первоисточников классической мусульманской юриспруденции, философских трактатов и работ современных исламских мыслителей с применением историко-сравнительного и сравнительно-правового методов. Сопоставляются нормативно-юридический подход факихов (аль-Маварди, Ибн Таймии, аль-Газали) и этико-философские воззрения мусульманских философов (аль-Фараби). ***Результаты и обсуждение.*** В ходе работы обнаружены существенные различия между суннитской договорной моделью легитимации власти и шиитской доктриной имамата. Прослежена трансформация исламской политической мысли в X–XXI веках: от классических идей аль-Фараби до концепций политического ислама аль-Маудуди и Сайида Кутба, а также современных дискуссий об исламской демократии. ***Заключение.*** По итогам проведенного исследования можно сделать вывод о том, что современная исламская политико-правовая доктрина демонстрирует гибкость и плюралистичность, допуская различные формы государственного устройства при условии реализации основополагающих целей шариата.

Ключевые слова: исламская политико-правовая мысль, халифат, имамат, шариат, государственность, политический ислам, исламская демократия, легитимность власти, шура, умма, теократия.

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Research article

Problems of power and statehood in Islamic political and legal thought

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Abstract. ***Introduction.*** The article presents a description of the evolution of concepts of power and statehood in Islamic political and legal thought from the classical period to the present day, examining the interrelation between religious doctrines and the political practice of Muslim society. ***Goal.*** To identify problems and prospects for the development of Islamic political and legal doctrine in the context of transforming notions of the legitimacy of power and forms of government. ***Materials and methods.*** The research is based on the analysis of primary sources of classical Muslim jurisprudence, philosophical treatises, and works of contemporary Islamic thinkers, employing historical-comparative and comparative-legal methods. The normative-legal approach of the fuqaha (al-Mawardi, Ibn Taymiyyah, al-Ghazali) is compared with the ethical-philosophical views of Muslim philosophers (al-Farabi). ***Results and discussion.*** The study revealed significant differences between the Sunni contractual model of legitimizing power and the Shia doctrine of the imamate. The transformation of Islamic political thought in the 20th–21st centuries was traced: from the secular ideas of Ali Abdel Raziq to the concepts of political Islam by al-Maududi and Sayyid Qutb, as well as contemporary debates on Islamic democracy. ***Conclusion.*** Based on the results of the conducted research, it can be concluded that contemporary Islamic political and legal doctrine demonstrates flexibility and pluralism, allowing various forms of government provided they implement the fundamental objectives of Sharia.
Key words: Islamic political and legal thought, caliphate, imamate, Sharia, statehood, political Islam, Islamic democracy, legitimacy of power, shura, ummah, theocracy.
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Introduction. Concepts of authority and state in Islamic political and legal thought were shaped by religious doctrines and the historical practice of Muslim society. From its earliest centuries, Islamic civilization demonstrated the inextricable link between the religious and political spheres: the Prophet Muhammad acted simultaneously as spiritual leader and head of the community (ummah), thereby setting a precedent for the unification of secular and spiritual authority. Subsequently, classical Muslim thinkers sought to understand the nature of authority based on the Quran and Sunnah, attempting to define the ideal Islamic state. Although the Quran and hadith contain only a few direct instructions on the organization of public authority, medieval theologians and jurists (faqihs) developed a holistic concept of the Islamic state, centered around the institution of the caliphate as the successor to the authority of the Prophet [4]. In classical Sunni theory, the caliphate was understood as a theocratic monarchy, where the ruler-caliph is considered God's viceroy on earth, responsible for the implementation of divine law (sharia) and the protection of the ummah. However, unlike the Shia tradition, which attributes questions of power to dogmatics (the doctrine of the imamate as a divinely established

institution), Sunni thought viewed public authority primarily through the prism of Islamic jurisprudence (fiqh), which gave its theories a more practical and legal character. This study, relying on a historical-comparative method and source analysis, traces the evolution of ideas about power and the state from classical Islamic political and legal thought to its contemporary interpretations. This perspective allows us to identify the continuity and transformations in Islamic political and legal doctrine, which has not only theoretical but also practical significance (given contemporary discussions about the role of Islam in the politics and law of Muslim countries).

Research Materials and Methods. The methodological basis of this study is a comparison of normative-legal and ethical-philosophical approaches to the phenomenon of power, developed within the Muslim intellectual tradition. The first approach—the normative-legal—is evident in the treatises of classical fuqaha, who, based on a few Quranic and prophetic injunctions, gradually developed a system of specific legal norms regulating the structure and functions of the Islamic state. The second approach—the ethical-philosophical—was embodied in the works of medieval Muslim philosophers (falasifa), who adopted the ancient heritage and sought to substantiate the ideal state structure from the standpoint of rational ethics. The study incorporates both approaches: through an analysis of the works of Muslim jurists (such as al-Mawardi, Ibn Khaldun, al-Ghazali, and others), it reconstructs the classical theory of the caliphate as a specific form of government, while references to philosophical treatises (such as al-Farabi) identify alternative conceptions of the state. Furthermore, a comparative method is employed to compare Sunni and Shia ideas, since, despite a common Islamic foundation, these two branches offered different justifications for the legitimacy of power (contractualism for Sunnis and imamate for Shiites). The final stage analyzes the modernization of political and legal thought in modern and contemporary times—from the reformist ideas of the early 20th century to the ideologies of contemporary Islamist movements. This integrated approach, combining historical, genetic, and comparative legal analysis, allows for a comprehensive scholarly presentation of the topic.

Research Results and Discussion. In classical Islamic political and legal doctrine, the institution of the caliphate—the authority of the caliph as the successor of the Prophet and head of the entire Muslim community—occupied a central place. After the death of Muhammad, the need arose for a leader who would unite the ummah and continue to guide the community in both spiritual and secular affairs. The Sunni tradition developed the doctrine of the caliphate, according to which legitimate authority is established on the basis of the oath (bay'ah) of the community to the elected leader. One of the first systematizers of this theory, al-Mawardi (11th century), in his work "Ahkam al-Sultaniya," focused primarily on the status of the imam-caliph, his duties, and the procedure for election. The imamate, according to al-Mawardi, arises through the conclusion of a unique social contract between the imam and the Muslim community (ummah). The ruler receives authority on the condition that he observes Sharia and protects the interests of Islam, and the community is obliged to obey him [7, pp. 179-188]. In the list of requirements for the caliph, the classics named male gender, belonging to the Quraysh tribe (a traditional condition deduced from the hadith), justice, knowledge of religion and the ability to govern [11, p. 278; 13, p. 12]. The duties of the caliph included supporting religion, enforcing Sharia laws, ensuring justice and security, collecting zakat and managing state finances, protecting borders and waging jihad against aggressors. Thus, the caliphate was conceived of as a theocratic government, where power is sanctioned by God's law and limited by it. In other words, the caliph (Arabic - "viceroy") is not a sovereign in the secular sense, but a trustee and custodian of the religious and legal system. Classical theory emphasized that the purpose of government is to ensure compliance with Sharia and the well-being of the ummah; the secular functions of government are inseparable from the religious ones.

However, the actual historical evolution of the caliphate led to the emergence of more complex forms of political organization than the early ideals envisaged. Already in the era of the Rightly Guided Caliphs (7th century), the model of collective election of the community leader

was combined with elements of monarchical succession (for example, the appointment of a successor during the caliph's lifetime). During the Umayyad and Abbasid periods, the caliphate evolved into a large empire, and the caliph's single supreme authority became largely nominal in relation to a ramified system of governors and sultans. By the 10th century, actual governance of many provinces had passed to local dynasties, which recognized the caliph's spiritual authority only symbolically. The renowned orientalist V.V. Bartold noted that from the time of the Abbasids, dualism was established: the caliph retained a religious and legitimizing role, while secular power was concentrated in the hands of military rulers – the sultans [1, p. [15-78]. The caliph became a kind of "pope" of the Islamic world, embodying the idea of the unity of the ummah, while the sultans and emirs exercised real dominance at the local level. This diarchy (the dualism of "caliph-sultan") was also reflected in theory: medieval jurists allowed that, in the event of the caliph's weakness or incapacity, his governing functions could be performed by a strong sultan, who received the title of emir al-umara (commander-in-chief). Nevertheless, Sunni doctrine could not completely abandon the idea of a single caliph: the unity of the ummah was considered a religious imperative, and polyarchy an undesirable anomaly [10, pp. 229-231, 234]. Only a few thinkers dared to theorize the possibility of a plurality of states. For example, the Hanbali theologian Ibn Taymiyyah (13th–14th centuries), who lived through the collapse of the caliphate and the Mongol invasion, argued that there was no strict necessity for a single caliph. If Muslim communities were geographically separated, the existence of several rulers simultaneously was permissible [17, p. 12]. He recognized that religion and state should go hand in hand, but he prioritized the principles of Sharia, not a specific form of government. According to Ibn Taymiyyah, it was sufficient for the government to ensure the unity of faith and the observance of Islamic law. At the same time, he placed two main requirements on the ideal ruler: the ability to govern effectively and commitment to religion [8, pp. 343–348]. This point of view, bold for its time, in many ways contradicted the orthodox concept of the caliphate, but anticipated the modern pluralistic approach, which allows for various forms of Islamic government.

Alongside the normative and legal canon of the caliphate theory, a philosophical and political tradition, drawing on ancient philosophy, developed in Muslim thought. Its prominent representative was Abu Nasr al-Farabi (9th-10th centuries), who is called the "second teacher" after Aristotle in the classical Muslim intellectual tradition. In his treatise "Opinions of the Inhabitants of the Virtuous City," al-Farabi outlined the ideal of a perfect society, clearly echoing Plato's utopia. He considered the city-state (al-Madina), analogous to the polis, to be the primary form of a perfect society, and it is the word "city" that he uses as equivalent to the concept of state [3, pp. 243-247]. In al-Farabi's virtuous city, the ruler is a philosopher, possessing perfect wisdom and virtue; in fact, this is the image of a prophet-imam, combining religious guidance with philosophical knowledge. Such a ruler leads society not by force of coercion, but by persuasion and example, guiding citizens toward happiness and perfection. Al-Farabi presents the state as a hierarchically structured organism, similar to a healthy body, in which different groups of people perform "organic" functions for the common good. Al-Farabi's concept synthesized Islamic values with Hellenistic political ethics, according to which the ideal is a just sage on the throne, implementing divine law in the most rational manner. The influence of this philosophical idea is felt in later Muslim thought. For example, Ibn Rushd (Averroes) in the 12th century also discussed the "philosophical imam" [16, p. 4], and in modern times, images of an "Islamic utopia" have inspired reformers. However, for medieval orthodox Islam, philosophical utopias remained a secondary trend, while the theory of the caliphate, more firmly connected with religious practice, was still dominant.

Shiite political and legal thought, which developed along different lines, deserves special mention. Shiites based their thinking on the doctrine of divinely instituted authority—the Imamate. According to the Twelver (Imamite) Shiite doctrine, after the Prophet, the leadership of the ummah was rightfully vested in the imams of the lineage of Ali ibn Abu Talib, endowed

with infallibility (ma'sum) and special knowledge. State power not vested in the legitimate imam was viewed by Shiites as a usurpation, permissible only out of necessity. After the twelfth imam went into hiding (c. 9th century), Shiite theory long recognized any secular governance as merely a temporary surrogate, lacking full legitimacy. Shiite jurists al-Mufid and at-Tusi permitted subjects to obey de facto rulers for the sake of maintaining order, but the ideal was to await the return of the Imam Mahdi, who would restore just divine rule [12, pp. 65–66, 87–88, 152]. Thus, the Shiite concept of authority had a more sacred and messianic character (legitimate authority emanates from God's appointee). This attitude largely predetermined the unique path of Shiite societies. For example, in Iran under the Safavids, secular shahs attempted to rely on the Shiite clergy to sanction their authority, proclaiming themselves the Imam's viceroys. Overall, Shiite political theory did not develop a developed model of a state without an Imam until the 20th century. Only in modern times did Grand Ayatollah Ruhollah Khomeini propose the concept of "velayat-i faqih" (the authority of the Islamic jurist), according to which the highest Shia theologian can fulfill the functions of ruler in the absence of the imam. This idea became a revolutionary innovation, laying the foundation for the Islamic Republic of Iran since 1979, where the spiritual leader (rahbar) – essentially the embodiment of the principle of velayat-i faqih – combines theocratic and governmental authority. It is important to emphasize that although Sunni and Shia thought proceed from different starting points (contractual legitimacy for the former and charismatic succession for the latter), both traditions see the ideal of authority as serving divine law and ensuring public piety. The differences, however, concern rather the question of who has the right to rule: a righteous man elected by the community (Sunnis) or an imam appointed by God from a specific lineage (Shiites)?

The beginning of the 20th century was marked by a crisis in the traditional model of the caliphate and the need to rethink Islamic political theory in the context of the new world order. This crisis culminated in the abolition of the Ottoman Caliphate in 1924, after which the Muslim world was divided into nation-states, often secular in nature. The intellectual reaction to the collapse of the caliphate paradigm resulted in polarized opinions among thinkers of the time. On the one hand, Ali Abdel Raziq, an Egyptian scholar and qadi, argued in his influential book Islam and the Foundations of Governance (1925) that the Prophet Muhammad did not establish a specific political model, and Islam does not require the creation of a theocratic state [19, p. 40]. In his view, the caliphate was a historical phenomenon without mandatory religious sanction; religion is a spiritual matter, and governance should be left to the discretion of reason and human experience. This secularizing interpretation provoked sharp criticism from the ulema. Abdel Raziq was accused of undermining the foundations of Sharia, his book was banned, and he was stripped of his title of Sheikh al-Azhar. In contrast, another prominent figure, Muhammad Rashid Rida, championed the need to revive the caliphate. In his work, "The Caliphate, or the Great Imamate" (1922), Rida acknowledged that the Ottoman model had outlived its usefulness, but he proposed reforming the institution of the caliphate—selecting a new caliph by consensus of leading Muslim peoples and giving him a more spiritual and coordinating function, uniting disparate states [5, p. 189]. Rida's ideas were never implemented, but they formed the basis for the programs of a number of Islamic movements. In 1928, the Muslim Brotherhood emerged in Egypt[1], declaring its goal to be the revival of the Islamic way of life and the construction of a state based on Islamic principles (though without initially directly demanding the restoration of the caliphate). Thus, at the beginning of the 20th century, two lines emerged: the reformist-secular (Abdel Raziq et al.), which accepted the separation of religion and state, and the revivalist-Islamist (Rida, Muslim Brotherhood), which sought to return politics to the mainstream of Sharia, albeit in an updated form.

In the mid-20th century, against the backdrop of decolonization and the crisis of post-war secular regimes, the Islamist movement, an ideology that demands the primacy of Islam in state life, gained momentum. One of the founders of modern political Islam was the Indo-Pakistani

[1]A terrorist organization banned in Russia.

thinker Abu Ala al-Maududi. He developed the concept of "theo-democracy," according to which sovereignty in the state belongs only to the Almighty, and people exercise power as his viceroys, following divine law [21, p. 24]. In his works, Maududi insisted that legislative power is limited by the Quran and Sunnah, but practical forms of government can include elected institutions and consultations (shura) [18]. Thus, Islamic governance should combine divine guidance with popular participation, without sliding into either a theocratic dictatorship or a liberal secular democracy. Maududi's calls found a response: in the 1940s and 1950s, In Pakistan and a number of other countries, a movement for the Islamization of legislation began, resulting in the enshrining in constitutions of norms stating that no law should contradict the principles of Islam. At the same time, a more radical idea, led by the Egyptian ideologist Sayyid Qutb, was gaining popularity in the Arab world. In his work Milestones (1964), Qutb declared modern secular society a state of jahiliyyah (ignorance, barbarism) and argued that true sovereignty belongs only to Allah (hakimiyyah), and all man-made systems (monarchies, republics, communism, etc.) usurp divine authority [14, p. 123; 20, p. 46]. From this conclusion, Qutb made a radical call: Muslims must create a vanguard that will overthrow wicked governments and establish rule according to Sharia. His ideas inspired generations of Islamists, including extremist organizations. While Maududi allowed for the gradual evolution of the state through reforms and elections, the Qutbist paradigm formed the basis of jihadist movements that justified armed uprisings against “non-Islamic” rulers.

At the same time, not all political Islam was reduced to extremes. Many moderate thinkers attempted to synthesize Islamic values with the institutions of the modern state. On this basis, the concept of "Islamic democracy" emerged, based on the principles of shura (consultation), ijtihad (reasonable interpretation), and the responsibility of rulers to the people, but within the moral and legal constraints of Sharia. For example, the Egyptian theologian Yusuf al-Qaradawi pointed out that Islam does not reject democratic procedures if they do not contradict faith. The election of the head of state, collegiality in decision-making, and respect for rights are fairly consistent with the Islamic principles of justice and consultation [22, pp. 12-24]. He and a number of other modern ulema believe that the form of government (monarchy, republic, federation) is not strictly predetermined by Sharia; it is more important that power be exercised on the basis of Islamic values (justice, service to society, compliance with Sharia norms in the public sphere) [6]. After the fall of the Caliphate, the Muslim world followed the path of nation-states, and most countries adopted constitutions declaring Islam the state religion or source of legislation. This became a compromise, as Sharia law was gradually incorporated into legal systems (especially in the areas of family and inheritance law), while the political form remained largely borrowed from the Western European model of the nation-state [2, pp. 93-95].

It is significant that by the late 20th and early 21st centuries, the idea of a secular state with an Islamic moral foundation, or a theoethical state, gained currency in Islamic discourse. This implies a secular mechanism of governance (institutions of parliament, elections, and separation of powers), but on the condition that Islam serves as the moral and legal guideline for legislation and policy. This formula was promoted, for example, by intellectuals who argued that the goal was not a theocracy of ayatollahs or a medieval-style caliphate, but democratic governance in which laws do not contradict Sharia [9, pp. 223-244]. In particular, in Tunisia and Egypt in 2011-2012, discussions were held about incorporating Sharia norms into the constitution, while recognizing the sovereign power of the people. Essentially, a balance was sought between the supremacy of divine law and popular sovereignty, which remains the subject of lively theological and legal debates to this day. Many theologians have concluded that a combined consideration of these principles is possible through the doctrine of "shura + ijma": decisions are made by elected bodies (shura), but within the framework of consensus (ijma) on fundamental Islamic values that cannot be overturned by a vote. This synthesis confirms the flexibility of Islamic political thought, capable of adapting to the challenges of the times while maintaining a commitment to tradition.

The revival of caliphate ideas in the modern era deserves special attention. Throughout the 20th century, movements calling for the restoration of a unified Islamic caliphate periodically emerged. One of these was the international organization Hizb ut Tahrir [2](Party of Liberation), founded in 1953 by Taqiyuddin Nabhani. In his works The Constitution of Islam and The System of Islam, Nabhani developed a utopian model of a modern caliphate: a unitary state headed by a caliph elected by Muslims, in which borders between Islamic countries are abolished and all laws are strictly based on Sharia [5, p. 189]. Hizb ut Tahrir does not participate in elections and rejects national governments as illegitimate; its activities, however, are banned or marginalized everywhere, and it has not achieved practical success in recreating the caliphate. A far more dramatic attempt was made by radical jihadists: the terrorist organization Islamic State of Iraq and the Levant (ISIS) [3], having captured significant territories in Syria and Iraq, proclaimed the restoration of the caliphate in June 2014. ISIS leader Abu Bakr al-Baghdadi declared himself Caliph Ibrahim, calling on all Muslims to offer bay'ah to him. However, leading Islamic scholars unanimously rejected ISIS's claims, pointing to gross violations of Sharia law, as a caliphate cannot be established unilaterally by a group of extremists ignoring the opinion of the entire ummah. Yusuf al-Qaradawi and other ulema emphasized that proclaiming a caliphate requires authority granted by the consensus of Muslim peoples, not the seizure of power by force; moreover, ISIS's atrocities and takfiri ideology place the organization outside of Islam. As a result, the ISIS "caliphate" was not recognized and was defeated militarily. This episode, on the one hand, discredited the idea of an immediate restoration of the caliphate by force, and on the other, it raised the question among Muslims: what should be the format of political unity of the ummah in the modern world? Some prominent Islamic thinkers responded that in the 21st century, a realistic form could be a supranational union or confederation of independent Muslim states. Thus, al-Qaradawi noted that the caliphate in our era is a federation or confederation of Muslim countries united by common values, and not necessarily a single state under a single ruler [15]. This approach effectively rethinks the classical utopia of a global caliphate, bringing it into line with modern principles of sovereignty and international relations.

Conclusion. The development of concepts of power and state in Islamic political and legal thought demonstrates the complex interweaving of religious ideals with historical realities. Classical doctrine developed in the Middle Ages and sacralized power, subordinating it to the goals of religion. In the form of the caliphate, it affirmed the principle of the unity of the spiritual and the secular: the ruler is conceived as the guardian of faith and law, and the state as the instrument for establishing divine justice on earth. Even medieval authors compared the ruler to a shepherd responsible for his flock (ummah), emphasizing that on the Day of Judgment, the imam will be required to render a special account for the people entrusted to him. These principles rested on the principle, fundamental to Muslims, that there is no true authority outside the framework of Islam, and the legitimacy of authority is measured by the extent of its service to Allah and the community of believers. The state, in turn, is conceived not as an intrinsic machine of coercion, but as a means of enforcing divine justice.

Modern interpretations retain this axiom, but have undergone significant transformations in the search for answers to the challenges of the new era. Islamic thought in the 20th and 21st centuries, having encountered the ideas of secularism, nationalism, and democracy, developed a wide range of views—from the complete separation of religion and state to demands for the total dominance of Sharia. At the same time, there is a tendency toward a convergence of moderate Islamic positions with the universal principles of the rule of law. Most modern Muslim intellectuals agree with the need for constitutionality, elected government, and respect for human rights, seeking to justify these institutions through the prism of Islam (concepts of shura, social contract, maslahat—the common good, etc.). At the same time, adherence to key traditional principles remains: in an Islamic society, the law must comply with Sharia, and politicians must

[2]A terrorist organization banned in Russia.
[3]A terrorist organization banned in Russia.

be guided by the moral norms of religion. Authority, in its ideal sense, is still viewed not so much as a privilege as a responsibility to God and others.

The concept of an Islamic state in modern interpretations has become more flexible and pluralistic. While a single caliphate was once the ideal, various models are now accepted, such as an Islamic republic (as in Iran), a constitutional monarchy, a federation of Islamic countries, and so on, provided they implement the fundamental goals of Sharia (the principle of justice, the protection of faith, life, reason, property, and the honor of subjects). Modern Muslim societies, having embraced the institutions of the nation-state, continue to search for the optimal form of realizing these ideals.

The experience of recent decades shows that excessive secularization, ignoring religious sentiments, is just as fraught with conflict as blind adherence to archaic models. In this regard, a monolithic understanding of power has now given way to a dialogue between tradition and modernism, and the success of this dialogue determines whether the Islamic political and legal heritage will become a resource for stability and development or a factor of discord. In any case, Islamic political and legal thought possesses sufficient internal diversity and dynamism to propose modern forms of exercising power without betraying its spiritual foundations.

It should be especially noted that studying the concepts of power and state in Islam is not only a look into the past but also a key to understanding the future of the Muslim world. Academic interest in this topic rightly remains high, as the Islamic understanding of power influences political processes in many regions of the world. Knowledge of classical foundations and modern interpretations helps accurately assess trends in state-building in Muslim countries, predict possible models for the development of Islamic statehood, and identify points of contact between religious and secular approaches in reforming political and legal systems.

Список источников

1. Бартольд В. В. Халиф и султан. Работы по истории ислама и Арабского халифата. М.: Наука, 2002. С. 15–78.
2. Гавриленко Н. С., Игнатенко Д. И. Ислам как основа государственности и правовой системы современных мусульманских стран. Ленинградский юридический журнал. 2024. № 1 (75). С. 90–106. https://doi.org/10.35231/18136230_2024_1_90
3. Нагиев Г. Г. Политическая философия Аль-Фараби и вызовы современного мира. Актуальные проблемы ветеринарной медицины: Сборник научных трудов, посвященный 90-летию Московской государственной академии ветеринарной медицины и биотехнологии имени К. И. Скрябина. М.: Московская государственная академия ветеринарной медицины и биотехнологии им. К. И. Скрябина, 2009. С. 243–247.
4. Сюкияйнен Л. Р. Исламская концепция халифата: исходные начала и современная интерпретация. Россия и мусульманский мир. 2017. № 9 (303). Availablefrom: https://cyberleninka.ru/article/n/islamskaya-kontseptsiya-halifata-ishodnye-nachala-i-sovremennaya-interpretatsiya [Accessed 25 November 2025].
5. Сюкияйнен Л. Р. Исламская правовая мысль об исламском государстве и халифате. Право. Журнал Высшей школы экономики. 2016. № 3. С. 185–205. https://doi.org/10.17323/2072-8166.2016.3.185.205
6. Хапчаев С. Т. Исламская концепция государственности в современном мире: проблема соотношения религиозного и политического начал. HumanProgress. 2024. Т. 10, № 10. https://doi.org/10.46320/2073-4506-2024-10a-34
7. Хапчаев С. Т. Социально-политическая философия аль-Маварди. Право и государство: проблемы методологии, теории и истории: Материалы XIII Всероссийской научно-практической конференции, Краснодар, 17 мая 2024 года. Краснодар: Краснодарский университет МВД РФ, 2024. С. 179–188.
8. Чанглян Л. Д. Классическая теория халифата в исламской философско-политической мысли. Социально-гуманитарные знания. 2021. № 5. С. 343–348. https://doi.org/10.34823/SGZ.2021.5.51698

9. Adrian M. F. Democracy, Human Rights and Islamic Law in Mohammed Abed Al-Jabiri's Reformist Ideas. Indonesian Journal of Interdisciplinary Islamic Studies. 2024. Vol. 7, No. 2. P. 223–244.
10. Al-Ghazali. Al-Iqtisad fi al-I'tiqad – Moderation in Belief. Translated by A. M. Yaqub. Chicago; London: UniversityofChicagoPress, 2013. 344 p.
11. Al-Ghazali. Al-Mustazhari. Translated by Richard J. McCarthy. New York: Twayne Publishers, 1980. 407 p.
12. Ali-Ahmad Rasekh. Agents of the Hidden Imam: Shiite Juristic Authority in Light of the Doctrine of Deputyship: PhD Dissertation. Montreal: ConcordiaUniversity, 2015. 203 p.
13. Al-Mawardi. The Laws of Islamic Governance (Al-Ahkam as-Sultaniyah). TranslatedbyAsadullahYate. London: TaHaPublishers, 2023. 354 p.
14. Choueiri Y. M. Islamic Fundamentalism. London: PinterPublishers, 1990. 178 p.
15. Collick Y. United in opposition, deviating in vision: the diverse response to the Islamic State's caliphate. MiddleEasternStudies. 2025. P. 1–16. https://doi.org/10.1080/00263206.2025.2540904
16. Ibn Rushd (Averroës). Commentary on Plato's Republic. Translated by Ralph Lerner. Ithaca, NY: Cornell University Press, 1974. 176 p.
17. Ibn Taymiyyah. Le traité de droit public d'IbnTaimiya. H. Laoust (trad.). Beyrouth, 1948. 271 p.
18. Islam J. Abul A'laMaududi: Innovator or Restorer of the Islamic Caliphate? International Journal of Political Theory. 2018. Vol. 3, No. 1. P. 1-13. Available from: https://philarchive.org/archive/ISLAAM [Accessed 26 November 2025].
19. Kassab E. S. Contemporary Arab Thought: Cultural Critique in Comparative Perspective. NewYork: ColumbiaUniversityPress, 2010. 496 p.
20. Kepel G. Muslim Extremism in Egypt: The Prophet and the Pharaoh. TranslatedbyJonRothschild. London: Al SaqiBooks, 1985. 234 p.
21. Maududi A. A. Islamic Law and Constitution. Translated by Khurshid Ahmad. Lahore: Islamic Publications Ltd., 1960. 439 p.
22. Ramadan R. A., Muzammil S. Democracy as Political Jihad: Evaluating Yusuf Qaradhawi's Vision and its Application in Indonesia. Islamic Thought Review. 2024. Vol. 2, No. 1. P. 12–24. https://doi.org/10.30983/itr.v2i1.7838

References

1. Bartol'd V. V. Khalif i sultan. Raboty po istorii islama i Arabskogo khalifata. M.: Nauka, 2002. S. 15–78.
2. Gavrilenko N. S., Ignatenko D. I. Islam kak osnova gosudarstvennosti i pravovoi sistemy sovremennykh musul'manskikh stran. Leningradskii yuridicheskii zhurnal. 2024. № 1 (75). S. 90–106. https://doi.org/10.35231/18136230_2024_1_90
3. Nagiev G. G. Politicheskaya filosofiya Al'-Farabi i vyzovy sovremennogo mira. Aktual'nye problemy veterinarnoi meditsiny: Sbornik nauchnykh trudov, posvyashchennyi 90-letiyu Moskovskoi gosudarstvennoi akademii veterinarnoi meditsiny i biotekhnologii imeni K. I. Skryabina. M.: Moskovskaya gosudarstvennaya akademiya veterinarnoi meditsiny i biotekhnologii im. K. I. Skryabina, 2009. S. 243–247.
4. Syukiyainen L. R. Islamskaya kontseptsiya khalifata: iskhodnye nachala i sovremennaya interpretatsiya. Rossiya i musul'manskii mir. 2017. № 9 (303). Availablefrom: https://cyberleninka.ru/article/n/islamskaya-kontseptsiya-halifata-ishodnye-nachala-i-sovremennaya-interpretatsiya [Accessed 25 November 2025].
5. Syukiyainen L. R. Islamskaya pravovaya mysl' ob islamskom gosudarstve i khalifate. Pravo. Zhurnal Vysshei shkoly ehkonomiki. 2016. № 3. S. 185–205. https://doi.org/10.17323/2072-8166.2016.3.185.205
6. Khapchaev S. T. Islamskaya kontseptsiya gosudarstvennosti v sovremennom mire: problema sootnosheniya religioznogo i politicheskogo nachal. HumanProgress. 2024. T. 10, № 10. https://doi.org/10.46320/2073-4506-2024-10a-34
7. Khapchaev S. T. Sotsial'no-politicheskaya filosofiya al'-Mavardi. Pravo i gosudarstvo: problemy metodologii, teorii i istorii: Materialy XIII Vserossiiskoi nauchno-prakticheskoi konferentsii, Krasnodar, 17 maya 2024 goda. Krasnodar: Krasnodarskii universitet MVD RF, 2024. S. 179–188.

8. Changlyan L. D. Klassicheskaya teoriya khalifata v islamskoi filosofsko-politicheskoi mysli. Sotsial'no-gumanitarnye znaniya. 2021. № 5. S. 343–348. https://doi.org/10.34823/SGZ.2021.5.51698
9. Adrian M. F. Democracy, Human Rights and Islamic Law in Mohammed Abed Al-Jabiri's Reformist Ideas. Indonesian Journal of Interdisciplinary Islamic Studies. 2024. Vol. 7, No. 2. P. 223–244.
10. Al-Ghazali. Al-Iqtisad fi al-I'tiqad – Moderation in Belief. Translated by A. M. Yaqub. Chicago; London: UniversityofChicagoPress, 2013. 344 p.
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12. Ali-Ahmad Rasekh. Agents of the Hidden Imam: Shiite Juristic Authority in Light of the Doctrine of Deputyship: PhD Dissertation. Montreal: ConcordiaUniversity, 2015. 203 p.
13. Al-Mawardi. The Laws of Islamic Governance (Al-Ahkam as-Sultaniyah). TranslatedbyAsadullahYate. London: TaHaPublishers, 2023. 354 p.
14. Choueiri Y. M. Islamic Fundamentalism. London: PinterPublishers, 1990. 178 p.
15. Collick Y. United in opposition, deviating in vision: the diverse response to the Islamic State's caliphate. MiddleEasternStudies. 2025. P. 1–16. https://doi.org/10.1080/00263206.2025.2540904
16. Ibn Rushd (Averroës). Commentary on Plato's Republic. Translated by Ralph Lerner. Ithaca, NY: Cornell University Press, 1974. 176 p.
17. Ibn Taymiyyah. Le traité de droit public d'IbnTaimiya. H. Laoust (trad.). Beyrouth, 1948. 271 p.
18. Islam J. Abul A'laMaududi: Innovator or Restorer of the Islamic Caliphate? International Journal of Political Theory. 2018. Vol. 3, No. 1. P. 1-13. Available from: https://philarchive.org/archive/ISLAAM [Accessed 26 November 2025].
19. Kassab E. S. Contemporary Arab Thought: Cultural Critique in Comparative Perspective. NewYork: ColumbiaUniversityPress, 2010. 496 p.
20. Kepel G. Muslim Extremism in Egypt: The Prophet and the Pharaoh. TranslatedbyJonRothschild. London: Al SaqiBooks, 1985. 234 p.
21. Maududi A. A. Islamic Law and Constitution. Translated by Khurshid Ahmad. Lahore: Islamic Publications Ltd., 1960. 439 p.
22. Ramadan R. A., Muzammil S. Democracy as Political Jihad: Evaluating Yusuf Qaradhawi's Vision and its Application in Indonesia. Islamic Thought Review. 2024. Vol. 2, No. 1. P. 12–24. https://doi.org/10.30983/itr.v2i1.7838

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Авторские права в журналистике

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Аннотация. ***Введение.*** Современная журналистика функционирует в условиях динамично развивающегося цифрового медиапространства, где процессы создания, распространения и защиты контента приобретают новые правовые и этические измерения. ***Материалы и методы.*** В данной статье рассмотрены особенности реализации и защиты авторских прав журналистов в России, проанализированы правовые основы регулирования интеллектуальной собственности в медиасфере, выявлены актуальные проблемы и противоречия между принципом свободы слова и защитой творческой индивидуальности автора. Особое внимание уделено проблемам служебного авторства, редакционной переработки, нарушения прав в интернете и развитию механизмов цифровой фиксации авторства. Цифровизация медиа не только расширила каналы дистрибуции, но и радикально усложнила вопросы установления и защиты авторских прав, породив ряд уникальных правовых коллизий. Исследование опирается на анализ нормативно-правовой базы, судебной практики и профессионально-этических кодексов журналистики. ***Результаты и обсуждение.*** В результате предложены направления совершенствования правоприменительной практики и правовой культуры в медиасфере. Ключевая роль принадлежит развитию правовой культуры и профессиональной этики, предполагающей как повышение юридической грамотности самих журналистов, так и формирование ответственного подхода у медиаорганизаций и потребителей контента. ***Заключение.*** В данной статье сделан вывод о необходимости междисциплинарного подхода к защите авторских прав журналистов, основанного на синтезе юридических, этических и технологических инструментов.

Ключевые слова: журналистика, авторское право, интеллектуальная собственность, служебное произведение, свобода слова, цифровизация, правовая защита.

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Research article

Copyright in journalism

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Abstract. ***Introduction.*** Modern journalism operates in a dynamically developing digital media space, where the processes of creating, distributing, and protecting content acquire new legal and ethical dimensions. This article examines the specifics of the implementation and protection of journalists' copyrights in Russia, analyzes the legal framework for regulating intellectual property in the media sector, and identifies current issues and contradictions between the principle of freedom of speech and the protection of the author's creative individuality. Special attention is given to the problems of corporate authorship, editorial processing, violations of rights on the Internet, and the development of mechanisms for digital attribution of authorship. Digitalization of the media has not only expanded distribution channels, but also radically complicated the issues of establishing and protecting copyrights, giving rise to a number of unique legal conflicts. The study is based on an analysis of the regulatory framework, court practice, and professional and ethical codes of journalism. ***Materials and methods.*** As a result, the paper proposes ways to improve law enforcement practices and legal culture in the media sector. ***Results and discussion.*** The key role is played by the development of legal culture and professional ethics, which involves both improving the legal literacy of journalists themselves and fostering a responsible approach among media organizations and content consumers. ***Conclusion.*** The paper concludes that there is a need for an interdisciplinary approach to protecting the copyrights of journalists, which combines legal, ethical, and technological tools.
s.
Key words: journalism, copyright, intellectual property, work of art, freedom of speech, digitalization, legal protection.
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Literature Review: Copyright issues in journalism have been actively explored in both legal and media theory literature over the past decades. The theoretical foundation for the development of copyright law is formed by the works of foreign and domestic authors, particularly L. Bentley and B. Sherman, who expound on the fundamental principles of copyright and related rights in the digital economy. A. A. Biryukov and I. V. Shirkova, as well as V. E. Chigirina, made significant contributions to the development of domestic copyright law, examining the legal nature of intellectual property and the mechanisms for protecting exclusive rights in civil law relations. Particular attention in the academic literature is devoted to the specifics of legal regulation of the media.

Research Method: The methodological basis of the study was formed by general scientific and specialized methods of legal analysis. A dialectical method allowed us to consider copyright in journalism as a dynamic category, changing under the influence of digitalization and societal transformations. A systems approach was used to analyze the relationships between the

legal, ethical, and technological aspects of journalistic activity. A comparative legal method was employed to compare domestic and international approaches to regulating copyright in the media. A formal legal analysis focused on the provisions of Part IV of the Civil Code of the Russian Federation, media legislation, and judicial decisions regulating official authorship and the adaptation of works. Content analysis was used to examine professional codes of journalistic ethics and identify their role in shaping the legal culture of journalists. The empirical method included an analysis of practical cases and court decisions reflecting trends in law enforcement in the area of journalistic copyright. The use of these methods allowed us to comprehensively examine the legal nature of journalistic work, identify problem areas in current legislation, and propose ways to improve legal regulation, taking into account the contemporary challenges of the media environment.

Research results: Modern journalism is a complex system of creative and informational activities, where the interests of the author, editorial staff, audience, and government intersect. With the digitalization of the media landscape—the introduction of digital technologies into various media activities, including the production and publication of online content—the protection of journalists' copyrights has become particularly pressing. Every day, a huge amount of text, photo, and video materials enter the information space, instantly disseminated via the internet, social media, and multimedia platforms. At the same time, the original work of a journalist—whether an analytical article, a report, or an interview — becomes vulnerable to illegal copying, editing, and reuse without the author's consent. In today's reality, any journalistic product can be a full-fledged multimedia project, incorporating various content formats (text, photo, video, digital). This creates additional conflicts in the process of determining copyright holders.

The Civil Code of the Russian Federation establishes that copyright is the intellectual property right to works of science, literature, and art. Copyright in journalism serves a dual function: on the one hand, it protects the interests of the creator, and on the other , it ensures the public right to receive reliable and up-to-date information.

Thus, we are talking about a balance between private and public interests. This balance is becoming especially important in the context of the development of new media, where the speed of information dissemination often conflicts with the principles of intellectual property. Unlike literary or artistic works, journalistic material is created in a context of information competition and often carries social significance, which raises questions about the limits of permissible quotation, reworking, and use of other people's texts [1].

The Russian Federation's legal framework regulating copyright has evolved gradually. The foundation is the Civil Code of the Russian Federation (Part Four), which defines the objects of copyright, the procedure for using works, the rights of authors, and related rights. Journalism, however, is unique, as many materials are created within the context of employment relationships — journalists write texts on behalf of editors. This raises the question: who owns the rights—the author or the employer? The answer depends on the contract form, the type of assignment, and the nature of the work.

An equally important issue is protecting the rights of journalists online. In the digital age, media texts and images are widely copied without attribution, undermining both the legal and ethical foundations of journalism. Copyright violations in the media sphere often go unpunished due to the difficulty of proving the fact of borrowing and the lack of uniform protection mechanisms [2]. At the same time, journalists themselves are playing an increasingly important role in shaping the legal culture of information use — understanding the limits of permitted quotation, registering rights to their materials, and correctly using other people's sources. For example, the legal status of interviews as intellectual property requires clearer regulation. Based on existing journalistic practice, one can conclude that the interviewer is considered a co-author of the resulting work due to their creative contribution: creating and posing the question, structuring the conversation. However, this rule may be unfair in cases where the uniqueness and value of the work is determined solely by the profound content of the public figure's response, and

not by the form of presentation. The lack of a contractual relationship between a journalist and an interviewee can lead to disagreements and even legal proceedings.

Thus, the issue of copyright in journalism is multifaceted. It encompasses legal, ethical, technological, and cultural aspects. Studying this issue not only helps us understand the mechanisms for protecting journalists' creative rights but also helps us determine how freedom of speech and intellectual property rights can harmoniously coexist.

The purpose of this study is to analyze the specifics of the implementation and protection of journalists' copyright in Russia, determine the specifics of the legal regulation of journalistic materials, and identify current problems and prospects for improving legislation in this area.

Copyright in journalism is a legal category that exists at the intersection of intellectual property and information law. The legal nature of a journalistic work is dual: it simultaneously represents an object of civil law protection and an element of public information circulation. This duality predetermines the complexity of law enforcement, especially in the context of the digitalization of the media space [3].

In Russian intellectual property law, copyright is defined as a set of rules governing relations arising from the creation and use of works of science, literature, and art (Civil Code of the Russian Federation, Part Four, Articles 1255–1301). Journalistic texts, according to paragraph 1 of Article 1259 of the Civil Code of the Russian Federation, are considered literary works and are subject to protection as the results of creative activity. However, the very form of journalistic expression, based on the interpretation of facts, does not preclude its creative uniqueness.

A distinctive feature of journalistic works is that they are created within the context of professional activity, often under an employment contract. In this regard, the concept of "works made for hire" (Article 1295 of the Civil Code of the Russian Federation) applies, according to which the exclusive right belongs to the employer, unless otherwise provided by the contract.

Thus, in journalism, a separation of moral and property rights often occurs: the author retains personal non-property rights (to his name, to the integrity of the text), while the editorial board receives an economic advantage in the disposal of the work.

It should be noted that legal doctrine has repeatedly emphasized the need to clarify the boundaries of official work in journalism [4]. In practice, difficulty arises in determining which materials can be considered created at the request of the employer, and which are the result of the journalist's independent creative initiative.

Journalistic text, especially in print and electronic media, often undergoes editing, fact-checking, and stylistic refinement. This can lead to pressing issues of co-authorship and editorial revision. According to Article 1258 of the Civil Code of the Russian Federation, authorship is recognized as joint only if the work is created through joint creative effort. Otherwise, editorial changes that are not creative in nature do not constitute co-authorship. However, in media practice, editorial revision often becomes the subject of legal disputes, as the line between editing and revision remains a matter of judgment.

Legal scholarship suggests viewing editorial editing as a derivative form of participation in the creation of a text, one that does not entail an independent right of co-authorship but does imply the obligation to preserve the journalist's name and the content of the work. In this sense, editorial activity is a component of the process of creating a journalistic product, rather than an independent creative act.

Copyright issues in the digital environment also depend on the degree of digitalization of the media space. Digitalization has significantly changed the nature of the legal regulation of authorship. In the context of online journalism, texts and other materials are instantly copied and distributed, making traditional forms of protection (such as authorship registration) ineffective. Consequently, digital rights recording mechanisms are becoming more relevant, including the deposit of electronic versions of materials, the use of blockchain services, and the application of digital watermarking systems.

The most common copyright violations committed by journalists online are:

– publication of materials without indicating the author and source;

– changing or distorting the text;

– re-posting of a work without the consent of the editors;

– use of fragments of an article for commercial purposes (for example, in blogs, news aggregators).

Judicial practice confirms that even minimal distortion of content or omission of an author's name may be considered a violation of personal non-property rights. For example, the Moscow District Arbitration Court's Ruling No. F05-19853/21 of November 24, 2021, stated that changing the title and partially abbreviating the text without the author's consent constitutes a violation of the right to the integrity of the work.

An analysis of current data also highlights the impact of digitalization on the transformation of legal protection for works, including journalistic texts, photographs, and video materials [5]. An analysis of judicial practice (Resolution of the Arbitration Court of the Moscow District dated November 24, 2021, No. F05-19853/21) demonstrates the evolution of approaches to recognizing journalistic materials as protectable objects of copyright.

In practice, it is important to maintain a balance between the right to information and the protection of authorship. Journalism, fulfilling the socially significant function of informing the public, faces the need to uphold the principle of freedom of speech (Article 29 of the Constitution of the Russian Federation) while maintaining legal protection of authorship. The balance between these principles is reflected in Article 1274 of the Civil Code of the Russian Federation, which provides for the possibility of free quotation for informational purposes. However, case law indicates the need for strict adherence to the quotation volume and the correct attribution of the source.

From a theoretical perspective, journalistic quotation is a tool of intertextual communication (in M. M. Bakhtin's terminology), but in a legal context, it should be considered the use of protected intellectual property. Consequently, journalistic freedom of quotation is limited by the boundaries of legitimate use, not absolute freedom of information.

The ethical and cultural aspects of copyright protection in journalism cannot, and should not, be considered solely in legal terms. Along with regulatory frameworks, professional ethics play a significant role. Codes of journalistic ethics, in particular the Code of Professional Ethics of Russian Journalists adopted by the Union of Journalists of Russia , stipulate the obligation to respect the intellectual rights of colleagues, avoid plagiarism, and faithfully cite sources.

Plagiarism in journalism not only violates legal norms but also undermines audience trust, reducing the public profile of the media. Issues of ethics and professional standards in journalistic activity are discussed in detail in [6] They consider plagiarism and respect for the intellectual rights of colleagues as part of a journalist's professional reputation. Academic literature emphasizes that developing a legal culture among journalists is a key condition for preserving authorial identity in the media [5].

Thus, A.E. Pautova analyzes the specifics of regulatory frameworks for media activities, and A.Yu. Fityo examines the balance between private and public interests in the field of copyright. Thus, modern scholarly thought views journalistic copyright as an interdisciplinary phenomenon that combines legal, ethical, and technological aspects, which determines the relevance of further research on this topic in the context of the digital transformation of media [7].

Current trends in the development of legal protection for journalistic materials are in one way or another linked to improved law enforcement practices and the need to modernize the regulatory framework. In terms of technology, a promising direction may be the implementation of systems for recording authorship and the time of creation of content. Among the relevant areas are:

– consolidation of the status of multimedia journalistic work as a complex object of copyright;

– development of electronic registers of copyright materials;

– introduction of voluntary licensing mechanisms in the media;

– improving the legal literacy of journalists through educational programs.

It seems appropriate to strengthen the role of self-regulatory organizations in journalism by empowering them with media ombudsman functions for copyright disputes. This will reduce the burden on the judicial system and strengthen the legal culture within the industry.

The conducted analysis of legal regulation and practice of implementing copyright in journalism of the Russian Federation allows us to draw a number of general conclusions.

Firstly, a journalistic work possesses all the attributes of a copyrighted object, as enshrined in Article 1259 of the Civil Code of the Russian Federation. At the same time, the specific nature of journalistic activity is determined by its social nature: a journalist creates a text not only as an individual creator but also as a participant in the public information process. This necessitates harmonizing the interests of the author, the editorial board, and society as a whole.

Current legislation adequately covers the basic forms of copyright protection, but requires further detail for the digital environment. Particularly challenging is the distinction between "works made for hire" and "derivative works," as well as determining the editorial contribution. Given the rapid development of online journalism, existing legal protection mechanisms have not always kept pace with technological advances.

Third, judicial practice in journalistic copyright cases demonstrates the gradual emergence of unified approaches. Courts are increasingly recognizing the protectability of journalistic materials, including reports, reviews, and analytical articles, provided they contain a creative element. The primary focus is on proving the originality of the form and structure of the text, rather than the fact of publication itself.

The digitalization of the media space requires a comprehensive update to approaches to the recording and protection of copyright [8]. A promising direction is the implementation of electronic systems for recording copyrighted works, the use of blockchain technologies and metadata for authorship verification, and the development of the practice of depositing journalistic materials in specialized registries.

Legal regulation of journalists' copyright is inextricably linked to professional ethics. Ethical standards of journalism strengthen legal guarantees, creating a sustainable culture of respect for intellectual work. Consequently, effective copyright protection in the media is impossible without the interaction of legal and moral norms [6].

Prospects for improving the institution of copyright in journalism are associated with the development and adoption of comprehensive measures, including:

clarification of the status of journalistic works in digital form;

development of mechanisms for pre-trial dispute resolution;

increasing the level of legal literacy of journalists;

expansion of educational programs on intellectual property in the media sphere;

creation of professional codes regulating the procedure for using other people's materials.

Overall, it can be concluded that copyright protection in journalism should be considered an integral part of the sustainable development of the information society. Effective legal protection of journalistic work helps strengthen trust in the media, maintain high professional standards, and foster a responsible media environment. A harmonious combination of freedom of speech and copyright protection is only possible with the continuous improvement of legislation and the development of a legal culture among all participants in the media process.

Copyright in journalism is a dynamically developing legal institution that combines elements of civil, informational, and ethical regulation [9]. This research suggests that the contemporary Russian media sphere is rethinking the role of intellectual property, its importance for maintaining professional journalism standards, and public trust in the media.

The analysis revealed that the existing regulatory framework—primarily Part IV of the Civil Code of the Russian Federation—provides basic guarantees for the protection of

journalists' copyright. However, the development of digital technologies, changing methods of information dissemination, and the transformation of labor relations in the media sphere require the adaptation of legislation to new realities. Particular attention should be paid to the development of legal mechanisms for copyright protection in the online environment, where traditional forms of attribution and control over the use of works prove insufficient.

The legal aspect of copyright in journalism cannot be considered in isolation from the ethical principles of the profession. Copyright compliance is part of a journalist's professional reputation, and copyright violations undermine audience trust and reduce the quality of public discourse. Therefore, fostering a legal culture in journalism should be considered a strategic direction for the development of the domestic media industry.

The dynamically evolving digital space is creating new realities for media content. Contemporary challenges—the growing number of content aggregators, the use of artificial intelligence for news generation, and the blurring boundaries between author and user—require an interdisciplinary approach [10]. A scholarly understanding of copyright in journalism should integrate legal, philological, and sociocultural approaches. This integrative understanding will enable the development of more flexible and viable forms of legal regulation capable of meeting the demands of the digital age.

The practical significance of these findings is that protecting journalists' copyrights strengthens the legal status of the profession, improves the quality of media products, and fosters a fair system of relations between authors, editors, and society. A promising direction for further research is the analysis of the use of artificial intelligence in journalism and its impact on copyright law, as well as the development of legal regulation models that take into account the specific features of multimedia and online forms of journalistic creativity [11].

Overall, it can be concluded that the future of copyright in journalism depends on the legal system's ability to respond quickly to technological and social changes. Only through collaboration between the state, the professional community, and academic science can a stable legal environment be created that ensures a balance between freedom of information and the protection of the author's creative individuality.

Список литературы

1. Шупик В. О. О некоторых проблемах защиты авторского права в сети Интернет / В. О. Шупик // Научные школы. Молодежь в науке и культуре XXI века: Материалы Международного научно-творческого форума (научной конференции), Челябинск, 24–25 ноября 2022 года. Челябинск: Челябинский государственный институт культуры, 2023. С. 132-134. EDNGCFAFW.
2. Маврина В. Ф. Правовые позиции конституционного суда в сфере интеллектуальной собственности / В. Ф. Маврина // Миссия права 2023: Сборник материалов Всероссийской научно-практической конференции с международным участием, посвященной 30-летию принятия Конституции Российской Федерации, Великий Новгород, 09 апреля 2023 года. – Великий Новгород: Новгородский государственный университет им. Ярослава Мудрого, 2023. С. 119-125. DOI 10.34680/978-5-89896-886-1/2023.ML.17. EDNFGNTST.
3. Фитьо А. Ю. Инновации в сфере кибербезопасности в эпоху цифровизации / А. Ю. Фитьо // Перспективы развития информационных систем и технологий в современном обществе: Материалы Всероссийской научно-практической конференции, Орёл, 31 мая 2024 года. – Орёл: Орловский государственный университет имени И.С. Тургенева, 2024. С. 511-515. EDN CRHVCA.
4. Болдырева Д. В. Договор как основание приобретения авторских прав в сфере журналистики / Д. В. Болдырева // Молодой ученый. 2025. № 2(553). С. 159-162. EDN KNNPIM.
5. Чигрина Е. В. Защита авторских прав в журналистике / Е. В. Чигрина // Евразийский юридический журнал. 2025. № 5(204). С. 226-228. EDN PILHFA.
6. Богомазова Н. Л. Современные медиа-этические конфликты ценностей / Н. Л. Богомазова, Г. В. Валеева, А. В. Слобожанин // Наука и современное общество: актуальные вопросы, достижения и инновации: Сборник статей II Международной научно-практической

конференции, Пенза, 27 марта 2020 года. – Пенза: "Наука и Просвещение" (ИП Гуляев Г.Ю.), 2020. С. 137-140. EDN OKAIKK.

7. Паутова А. Е. Авторское право в журналистике / А. Е. Паутова, Е. А. Скорых // Информационное пространство в аспекте гуманитарных и технических наук - 2019: Сборник статей VIII междисциплинарной межвузовской конференции студентов, магистрантов, аспирантов, Барнаул, 28 ноября 2019 года / Под редакцией А.В. Чутчевой, П.С. Ладыгина. Барнаул: Алтайский государственный университет, 2020. С. 83-88. EDN UWCVEO.
8. Витко В. С. Понятие формы произведения в авторском праве / В. С. Витко. – Москва: ООО «Издательство «СТАТУТ», 2020. 268 с. ISBN 978-5-8354-1676-9. EDN HSBJIG.
9. Osipova M. V. The Information security of computer games and problems associated with the protection of the rights of users and companies / M. V. Osipova, M. Yu. Petrov // Modern Science and Innovations. – 2024. – No. 3(47). – P. 211-219. – DOI 10.37493/2307-910X.2024.3.23. – EDN BSLOFN.
10. Петров Д. В. Защита авторских прав на использование персонажа/ Д. В. Петров // Управление социально-экономическим развитием: инновационный и стратегический подходы: сборник научных трудов по материалам Национальной научно-практической конференции, Гатчина, 23 декабря 2022 года. Гатчина: Государственный институт экономики, финансов, права и технологий, 2023. С. 305-307. EDN BSPEIH.
11. Балашов Н. С. Особенности охраны искусственного интеллекта / Н. С. Балашов, М. В. Осипова // Миссия права 2023: Сборник материалов Всероссийской научно-практической конференции с международным участием, посвященной 30-летию принятия Конституции Российской Федерации, Великий Новгород, 09 апреля 2023 года. Великий Новгород: Новгородский государственный университет им. Ярослава Мудрого, 2023. С. 30-37. DOI 10.34680/978-5-89896-886-1/2023.ML.04. – EDN DYYEUE.

References

1. Shupik V. O. O nekotorykh problemakh zashchity avtorskogo prava v seti Internet / V. O. Shupik . Nauchnye shkoly. Molodezh' v nauke i kul'ture XXI veka: Materialy Mezhdunarodnogo nauchno-tvorcheskogo foruma (nauchnoi konferentsii), Chelyabinsk, 24–25 noyabrya 2022 goda. Chelyabinsk: Chelyabinskii gosudarstvennyi institut kul'tury, 2023. S. 132-134. EDNGCFAFW.
2. Mavrina V. F. Pravovye pozitsii konstitutsionnogo suda v sfere intellektual'noi sobstvennosti / V. F. Mavrina // Missiya prava 2023: Sbornik materialov Vserossiiskoi nauchno-prakticheskoi konferentsii s mezhdunarodnym uchastiem, posvyashchennoi 30-letiyu prinyatiya Konstitutsii Rossiiskoi Federatsii, Velikii Novgorod, 09 aprelya 2023 goda. Velikii Novgorod: Novgorodskii gosudarstvennyi universitet im. Yaroslava Mudrogo, 2023. S. 119-125. DOI 10.34680/978-5-89896-886-1/2023.ML.17. EDNFGNTST.
3. Fit'o A. YU. Innovatsii v sfere kiberbezopasnosti v ehpokhu tsifrovizatsii / A. YU. Fit'o // Perspektivy razvitiya informatsionnykh sistem i tekhnologii v sovremennom obshchestve: Materialy Vserossiiskoi nauchno-prakticheskoi konferentsii, Orel, 31 maya 2024 goda. Orel: Orlovskii gosudarstvennyi universitet imeni I.S. Turgeneva, 2024. Pp. 511-515. EDN CRHVCA.
4. Boldyreva D. V. Dogovor kak osnovanie priobreteniya avtorskikh prav v sfere zhurnalistiki / D. V. Boldyreva. Molodoi uchenyi. 2025. № 2(553). Pp. 159-162. EDN KNNPIM.
5. Chigrina E. V. Zashchita avtorskikh prav v zhurnalistike / E. V. Chigrina. Evraziiskii yuridicheskii zhurnal. 2025. № 5(204). Pp. 226-228. EDN PILHFA.
6. Bogomazova N. L. Sovremennye media-ehticheskie konflikty tsennostei / N. L. Bogomazova, G. V. Valeeva, A. V. Slobozhanin. Nauka i sovremennoe obshchestvo: aktual'nye voprosy, dostizheniya i innovatsii: Sbornik statei II Mezhdunarodnoi nauchno-prakticheskoi konferentsii, Penza, 27 marta 2020 goda. Penza: "Nauka i Prosveshchenie" (IP Gulyaev G.YU.), 2020. Pp. 137-140. EDN OKAIKK.
7. Pautova A. E. Avtorskoe pravo v zhurnalistike / A. E. Pautova, E. A. Skorykh // Informatsionnoe prostranstvo v aspekte gumanitarnykh i tekhnicheskikh nauk - 2019: Sbornik statei VIII mezhdistsiplinarnoi mezhvuzovskoi konferentsii studentov, magistrantov, aspirantov, Barnaul, 28 noyabrya 2019 goda / Pod redaktsiei A.V. Chutchevoi, P.S. Ladygina. – Barnaul: Altaiskii gosudarstvennyi universitet, 2020. Pp. 83-88. EDN UWCVEO.

8. Vitko V. S. Ponyatie formy proizvedeniya v avtorskom prave / V. S. Vitko. – Moskva: OOO «Izdatel'stvo «STATUT», 2020. 268 s. ISBN 978-5-8354-1676-9. EDN HSBJIG.
9. Osipova M. V. The Information security of computer games and problems associated with the protection of the rights of users and companies / M. V. Osipova, M. Yu. Petrov. Modern Science and Innovations. . 2024. .No. 3(47). Pp. 211-219. DOI 10.37493/2307-910X.2024.3.23. –EDN BSLOFN.
10. Petrov D. V. Zashchita avtorskikh prav na ispol'zovanie personazha/ D. V. Petrov // Upravlenie sotsial'no-ehkonomicheskim razvitiem: innovatsionnyi i strategicheskii podkhody: sbornik nauchnykh trudov po materialam Natsional'noi nauchno-prakticheskoi konferentsii, Gatchina, 23 dekabrya 2022 goda. – Gatchina: Gosudarstvennyi institut ehkonomiki, finansov, prava i tekhnologii, 2023. Pp. 305-307. EDN BSPEIH.
11. Balashov N. S. Osobennosti okhrany iskusstvennogo intellekta / N. S. Balashov, M. V. Osipova // Missiya prava 2023: Sbornik materialov Vserossiiskoi nauchno-prakticheskoi konferentsii s mezhdunarodnym uchastiem, posvyashchennoi 30-letiyu prinyatiya Konstitutsii Rossiiskoi Federatsii, Velikii Novgorod, 09 aprelya 2023 goda. Velikii Novgorod: Novgorodskii gosudarstvennyi universitet im. Yaroslava Mudrogo, 2023. Pp. 30-37. DOI 10.34680/978-5-89896-886-1/2023.ML.04. EDN DYYEUE.

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