

## Brief information about the project

Name of the project	AP09057950 «Inverse problems for linear and nonlinear equations of non-newtonian viscoelastic incompressible Kelvin-Voigt fluids»
Relevance	<p>The development of modern science and technology requires an accurate and comprehensive mathematical study of various physical and hydrodynamic processes of continuous media.</p> <p>This completed project is devoted to the theoretical (existence, uniqueness and qualitative properties of the solution) and numerical (numerical solution) study of inverse problems of Kelvin-Voigt models of fluid motion and nonlinear equations of mathematical physics related to them. Therefore, the study of such inverse problems is relevant.</p>
Purpose	<p>The aim of the project is to create and develop a theory of solvability of inverse and direct problems for linear and nonlinear Kelvin-Voigt and partial differential equations describing the motion of viscoelastic incompressible non-Newtonian fluids.</p>
Objectives	<ul style="list-style-type: none"><li>➤ To prove the unique solvability of the inverse problem of recovering the coefficient of the right-hand side of a linear integro-differential Kelvin-Voigt equation depending on spatial variables with an integral overdetermination condition.</li><li>➤ To prove the existence and uniqueness of a generalized solution to the inverse problem of recovering the coefficient of the right-hand side of the time-dependent linear integro-differential Kelvin-Voigt equation, describing the dynamics of one of the viscoelastic non-Newtonian fluids.</li><li>➤ To prove the unique solvability of the inverse problem of thermal convection for an incompressible viscoelastic Kelvin-Voigt fluid.</li><li>➤ To prove unique solvability of inverse problem of determining the coefficient of the right-hand side, depending on time, for the nonlinear generalized Kelvin-Voigt equation with a nonlinear source (with a damping term)/ with a nonlinear sink (with absorption).</li><li>➤ To establish the condition for destruction in a finite time for solving the inverse problem of the nonlinear generalized Kelvin-Voigt equation with a nonlinear source (with a damping term);</li><li>➤ To recover the pressure from the generalized Kelvin-Voigt equation with the diffusion (p-Laplacian) and damping term for inhomogeneous liquids.</li><li>➤ To establish the solvability of the coefficient inverse problem for a degenerate parabolic equation with a variable direction of evolution;</li></ul>

	<ul style="list-style-type: none"> <li>➤ To prove the existence and uniqueness of a solution to the coefficient inverse problem for a pseudoparabolic equation with an integral overdetermination condition.</li> <li>➤ To create and establish convergence conditions for difference schemes for a pseudoparabolic equation describing the process of one non-Newtonian fluid.</li> </ul>
Obtained results and novelty	<ul style="list-style-type: none"> <li>➤ The unique solvability of the inverse problem of recovering the coefficient of the right-hand side depending on the spatial variable for the linear integro-differential Kelvin-Voigt equation supplemented with the final and integral overdetermination condition was proved.</li> <li>➤ Theorems for the existence and uniqueness of a generalized solution to the inverse problem of recovering a coefficient of the right-hand side, depending on time, for the linear integro-differential Kelvin-Voigt equation describing the dynamics of a viscoelastic incompressible non-Newtonian fluid were proved.</li> <li>➤ The solvability of the inverse problem of heat convection for an incompressible viscoelastic Kelvin-Voigt fluid was proved.</li> <li>➤ The unique solvability of the inverse problem of determining the coefficient of the time-dependent right-hand side for the nonlinear generalized Kelvin-Voigt equation with a nonlinear source (with a damping term)/with a nonlinear sink (with absorption) was proved.</li> <li>➤ The conditions for blowing up in a finite time of solutions of the inverse problem for the nonlinear generalized Kelvin-Voigt equation with a nonlinear source (with a damping term) are obtained.</li> <li>➤ The pressure was recovered from the generalized Kelvin-Voigt equation with p-Laplacian for nonhomogeneous fluids.</li> <li>➤ The solvability of the coefficient inverse problem for a degenerate parabolic equation with a variable direction of evolution was established.</li> <li>➤ The existence and uniqueness of solution of the coefficient inverse problem for a pseudoparabolic equation with an integral overdetermination condition were proved.</li> <li>➤ Conditions for the convergence of finite-difference schemes for a pseudoparabolic equation, describing the process of one non-Newtonian fluid, was created and established.</li> </ul>
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List of publications with links to them	<p><b>Indexing in Scopus и Web of Science:</b></p> <p><b>1. S.N. Antontsev, Kh. Khompysh.</b> An inverse problem for generalized Kelvin-Voigt equation with p-Laplacian and damping term. Inverse Problems. -37. №8. -2021. <b>Scopus: 84%, Web of Science: Q1</b></p> <p><b>2. Kh. Khompysh, N. Nugymanova.</b> Inverse Problem for Integro-Differential Kelvin-Voigt Equation//Inverse and ill-posed problem, -31(6) p.835-847. -2023. Accepted. <b>Scopus: 56%, Web of Science: Q2</b></p> <p><b>3. S.N. Antontsev, S.E. Aitzhanov, D.T. Zhanuzakova.</b> An initial boundary value problem for a pseudoparabolic equation with a nonlinear boundary condition//Math. Meth. Appl. Sci. -46(1). p.1111-1136. -2023. <b>Scopus: 91%, Web of Science: Q1</b></p> <p><b>4. Kh. Khompysh, Kh. Kenzhebai.</b> An inverse problem for Kelvin–Voigt equations perturbed by isotropic diffusion and damping// Math. Meth. Appl. Sci. №45. 3817-3842. 2022. <b>Scopus: 91%, Web of Science: Q1</b></p> <p><b>5. A. Shakir, Kh. Khompysh.</b> Time Dependent Inverse Source Problems for Integrodifferential Kelvin-Voigt System// Trends in Mathematics Series: Research Perspectives. Ghent Analysis and PDE Center. — 2023. Accepted. <b>Scopus: 7%.</b></p> <p><b>6. S.E. Aitzhanov, G.R. Ashurova, K.A. Zhalgassova.</b> Identification of the right hand side of a quasilinear pseudoparabolic equation with memory term// Jour. of Math., Mech. and Comp. Sci.-110. №2. pp. 47-63. -2021. <b>Web of Science-Q4, Scopus- 0%.</b></p> <p><b>7. Kh. Kenzhebai.</b> An inverse problem of recovering the right hand side of 1d pseudoparabolic equation Jour. of Math., Mech. and Comp. Sci. -111. №3. pp. 28-37. -2021. <b>Web of Science-Q4, Scopus- 0%.</b></p> <p><b>8. A. Kozhanov, U. Abylkayrov, G. Ashurova.</b> Inverse problems of determining coefficients of time type in a degenerate parabolic equation. Bulletin of the Karaganda university Mathematics series. №2(106), p.128-142, -2022. <b>Web of Science: Q3, Scopus– 35%</b></p>

	<p><b>9. A. Shakir.</b> Global solvability of inverse problem for linear Kelvin-Voigt equations with memory, Journal of Mathematics, Mechanics and Computer Science. – 118 (2). p.30-41, -2023. <b>Web of Science-Q4, Scopus- 0%</b>.</p> <p><b>10. S. Aitzhanov, A. Isakhov, K. Zhalgassova, G. Ashurova.</b> The coefficient inverse problem for a pseudoparabolic equation of the third order//Journal of Mathematics, Mechanics and Computer Science. -2023. - Vol. 119, No. 3. -P. 3-18. <b>Web of Science-Q4, Scopus-0%</b>.</p> <p style="text-align: center;"><b>Proceedings, conference materials:</b></p> <ol style="list-style-type: none"> <li>1. <b>Kh. Khompysh, A. Shakir, X. Gao.</b> An inverse problem for pseudoparabolic equations with p-Laplacian. Международная научная конференция «проблемы современной математики и ее приложения, 16-19 июня 2021, Бишкек, Кыргызстан.</li> <li>2. <b>Kh. Khompysh, N. Nugymanova.</b> An Inverse problem for Kelvin-Voigt Equation with memory//8th International Congress on Fundamental and Applied Sciences 2021 (ICFAS2021 <b>Материал конференции</b>), 19-21, October, 2021, Antalya, Turkey.</li> <li>3. <b>A. Shakir, Kh. Khompysh.</b> Blow-Up of Solutions of the Integro-Differential Kelvin–Voigt Equation. XII International Conference of the Georgian Mathematical Union, Batumi, August 29 – September 3, 2022. 44 p.</li> <li>4. S. N. Antontsev, <b>Kh. Khompysh.</b> An Inverse Problem for Heat Convection System of Kelvin–Voigt Fluids. XII International Conference of the Georgian Mathematical Union, Batumi, August 29 – September 3, 2022. 49 p.</li> <li>5. <b>Kh. Khompysha A. Shakir, M. Shazyndaeva, N. Nugymanova.</b> An inverse problem for linear Kelvin-Voigt equations with final overdetermination condition, Традиционная международная апрельская математическая конференция в честь дня работников науки республики казахстан, 5-8 апреля 2022, Алматы, Казахстан. 91 с.</li> <li>6. <b>A. Shakir, Kh. Khompysh..</b> Inverse problem for Kelvin-Voigt with memory, “Inverse and ill-posed problems in natural sciences” materials of the International scientific conference, April 11-12, 2023, p. 23.</li> <li>7. <b>A. Shakir, Kh. Khompysh.</b> Inverse problem for Kelvin-Voigt equations with memory, <b>Traditional international April scientific conference in honor of the Day of Science Workers of the Republic of Kazakhstan</b>, April 5-7, 2023, p.138.</li> </ol>
Patents	-