

Brief information about the project

Name of the project	AP26195073 - Inverse problems for nonlinear evolution equations with power-law diffusion and reaction
Relevance	Nonlinear evolutionary equations, especially models with power-law diffusion and reaction terms, are widely used to describe natural and social processes, including the spread of epidemics. Models with fractional derivatives are attracting increasing interest because they more accurately capture memory effects and anomalous diffusion. In this context, the study of inverse problems for such equations and the development of efficient analytical methods for their solutions represent an important and relevant scientific challenge today.
Purpose	The purpose of project is the comprehensively studying of various inverse problems for nonlinear evolution equations modified by power-law diffusion and reaction/damping and for their fractional analogies, epidemic spread equations, as well as the developing effective analytical methods for solving them.
Objectives	Inverse problems for nonlinear pseudo-parabolic and parabolic equations with the Caputo fractional time derivative, p-Laplacian diffusion, and power-type reaction–damping terms are studied. The main focus is on the recovery of time-dependent coefficients (source terms and potentials) using additional integral overdetermination conditions. Sufficient conditions for global and local-in-time existence and uniqueness of solutions are established for both source and absorption cases. Qualitative properties of solutions, including regularity, finite-time decay, and asymptotic behavior, are also investigated. Special cases of degenerate evolutionary equations and problems with multiple characteristics are considered, for which existence and uniqueness results are proved. In addition, a one-dimensional model of epidemic spread is developed, along with methods for solving the corresponding inverse problems.
Expected and achieved results	Sufficient conditions for the well-posedness (existence, uniqueness, and stability) of solutions to inverse problems for a broad class of nonlinear pseudo-parabolic and parabolic equations with the Caputo fractional time derivative, p-Laplacian diffusion, and power-type reaction–damping terms will be obtained. Global and local-in-time existence of weak solutions will be proved for both source and absorption cases. Unique solvability of inverse problems for recovering time-dependent coefficients (source terms and potentials) from integral overdetermination conditions will be established. Qualitative properties of solutions, including regularity, finite-time decay, and long-time asymptotic behavior, will be investigated. For degenerate third-order evolutionary equations with multiple characteristics, existence and uniqueness theorems will be

	proved. In addition, a one-dimensional mathematical model of epidemic spread will be developed and analyzed, and methods for solving the corresponding inverse problems will be proposed.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Shakir Aidos– Scopus Author ID: 57887170500, ORCID: 0000-0001-8572-0776 2. Khompysh Khonatbek – Scopus Author ID: 55785395700, ORCID: 0000-0002-5525-111X 3. Serovajsky Simon – Scopus Author ID: 14623297700, ORCID: 0000-0001-9514-9745 4. Kabadoldanova Assem – Scopus Author ID: 55321771300, ORCID: 0000-0001-6375-9805 5. Kenzhebai Khanat – Scopus Author ID: 57381328000, ORCID: 0000-0001-6787-128X 6. Ashurova Guzel – Scopus Author ID: 57428015200, ORCID: 0000-0001-5053-4981 7. Mukhambetkaliyev Murat– Scopus Author ID: 60083460800, ORCID: 000009-0007-9604-9544 8. Shazyndayeva Moldir – Scopus Author ID: 59046461700, ORCID: 0000-0002-6287-7823
Usage	The scope of this research covers the modeling of natural and social processes, in particular the description of substance transport, reaction–diffusion phenomena, and epidemic dynamics. In addition, the obtained results can be applied in medicine, ecology, and engineering systems for solving inverse problems, identifying parameters, as well as for the prediction and control of processes.
Priority compared to real-world alternatives	The priority compared to existing real-world analogues lies in accounting for the nonlocal effects of fractional-order diffusion when solving inverse problems for nonlinear evolutionary equations with reaction terms.
List of publications with links to them	1. Khompysh, Khonatbek, Mohammed J. Huntul, and M. Mukhambetkaliyev. (2025). “Time-Dependent Inverse Source Problems for a Pseudoparabolic Equation with Memory.” <i>Computers & Mathematics with Applications</i> 198: 239–254. https://doi.org/10.1016/j.camwa.2025.08.029. (Web of Science: Q1; Scopus: 82%). 2. Van Bockstal, Karel, and Khonatbek Khompysh. (2026). “A Time-Dependent Inverse Source Problem for a Semilinear Pseudo-Parabolic Equation with Neumann Boundary Condition.” <i>Computers & Mathematics with Applications</i> 208: 97–112. https://doi.org/10.1016/j.camwa.2026.01.038. (Web of Science: Q1; Scopus: 82%).
Patents	–