Johann Radon Institute for Computational and Applied Mathematics Austrian Academy of Sciences (ÖAW)

Group Seminar

Inverse Problems and Mathematical Imaging

Regularized reconstruction of the order in semilinear subdiffusion with memory

Sergii Siryk, Kyiv Polytechnic Institute

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Abstract

Abstract: In the last two decades, fractional partial differential equations play a key role in the description of the so-called anomalous phenomena. The signature of an anomalous diffusion is that the mean square displacement of the diffusing species $\langle(\mathbf{\Delta x})^2\rangle$ scales as a nonlinear power low in time, i.e. $\langle(\mathbf{\Delta x})^2\rangle \sim t^\nu$, $\nu > 0$. For a subdiffusive process, the value of ν is such that $0 < \nu < 1$, while for normal diffusion $\nu = 1$, and for a superdiffusive process, we have $\nu > 1$.
However, sometimes a value of the subdiffusion order is not given a priori. Here we discuss an approach to the reconstruction of a subdiffusion order ν from small time state measurements. To this end, analyzing an inverse problem for semilinear fractional partial differential equations with memory terms, we obtain the explicit formula reconstructing the order ν. The formula gives rise to a regularization algorithm for calculating ν from possibly noisy measurements. We present several numerical tests illustrating the algorithm when it is equipped with quasi-optimality criteria for choosing the regularization parameters.