

Inverse coefficient problems for one-dimensional time-fractional diffusion equations

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Abstract

We prove the uniqueness in determining a spatially varying zeroth-order coefficient of a one-dimensional time-fractional diffusion equation by initial value and Cauchy data at one end point of the spatial interval.

1 Introduction and main results

Let $\ell, T > 0$. By $L^2(0, \ell)$, $H^2(0, \ell)$, $W^{1,1}(0, T)$, $W^{1,1}(0, T; L^2(0, \ell))$, $L^2(0, T; H^2(0, \ell))$, etc., we denote the Lebesgue space and usual Sobolev spaces. For $0 < \alpha < 1$, we define the Caputo derivative: $d_t^\alpha v(t) = \frac{1}{\Gamma(1-\alpha)} \int_0^t (t-s)^{-\alpha} \frac{dv}{ds}(s) ds$ for $v \in W^{1,1}(0, T)$, where Γ denotes the gamma function (e.g., Podlubny [14]). Let $u = u(x, t) \in W^{1,1}(0, T; L^2(0, \ell)) \cap L^2(0, T; H^2(0, \ell))$ satisfy

$$d_t^\alpha u(x, t) = \partial_x^2 u(x, t) - p(x)u(x, t), \quad u(x, 0) = a(x) \in C^2[0, \ell], \quad 0 < x < \ell, \quad 0 < t < T.$$

This is a model system for example for anomalous diffusion in heterogeneous media (e.g., [14]). This article is concerned with

Inverse coefficient problem: Let $T > 0$ be arbitrarily fixed. Then determine $p(x)$, $0 < x < \ell$ by data $u(x, 0)$ for $0 < x < \ell$ and $u(0, t)$, $\partial_x u(0, t)$ for $0 < t < T$.

We state our first main result on the uniqueness.

Theorem 1 Let $p, q \in C^2[0, T]$, $a \in C^2[0, T]$ and $u, \tilde{u} \in W^{1,1}(0, T; L^2(0, \ell)) \cap L^2(0, T; H^2(0, \ell))$ satisfy

$$d_t^\alpha u(x, t) = \partial_x^2 u(x, t) - p(x)u(x, t), \quad u(x, 0) = a(x), \quad \partial_x u(0, t) = 0, \quad x \in \ell, \quad 0 < t < T \quad (1.1)$$

One Dimensional Inverse Problems Of Math

John Rozier Cannon



One Dimensional Inverse Problems Of Math:

One-Dimensional Inverse Problems of Mathematical Physics Mikhail Mikhaïlovich Lavrent'ev, K. G.

Reznitskaya, Valerii Georgievich Ĭakhno, 1986 A monograph that deals with the inverse problems of determining a variable coefficient and right side for hyperbolic and parabolic equations on the basis of known solutions at fixed points of space for all times *Inverse Problems of Mathematical Physics* V. G. Romanov, 2018-11-05 No detailed description available for

Inverse Problems Alexander G. Ramm, 2005-12-19 Inverse Problems is a monograph which contains a self contained presentation of the theory of several major inverse problems and the closely related results from the theory of ill posed problems The book is aimed at a large audience which include graduate students and researchers in mathematical physical and engineering sciences and in the area of numerical analysis *Introduction to Inverse Problems for Differential Equations* Alemdar Hasanov Hasanoğlu, Vladimir G. Romanov, 2021-08-02 This book presents a systematic exposition of the main ideas and methods in treating inverse problems for PDEs arising in basic mathematical models though it makes no claim to being exhaustive Mathematical models of most physical phenomena are governed by initial and boundary value problems for PDEs and inverse problems governed by these equations arise naturally in nearly all branches of science and engineering The book s content especially in the Introduction and Part I is self contained and is intended to also be accessible for beginning graduate students whose mathematical background includes only basic courses in advanced calculus PDEs and functional analysis Further the book can be used as the backbone for a lecture course on inverse and ill posed problems for partial differential equations In turn the second part of the book consists of six nearly independent chapters The choice of these chapters was motivated by the fact that the inverse coefficient and source problems considered here are based on the basic and commonly used mathematical models governed by PDEs These chapters describe not only these inverse problems but also main inversion methods and techniques Since the most distinctive features of any inverse problems related to PDEs are hidden in the properties of the corresponding solutions to direct problems special attention is paid to the investigation of these properties For the second edition the authors have added two new chapters focusing on real world applications of inverse problems arising in wave and vibration phenomena They have also revised the whole text of the first edition *Inverse Problems for Maxwell's Equations* V. G. Romanov, S. I.

Kabanikhin, 2014-10-10 No detailed description available for Inverse Problems for Maxwell s Equations Ill-posed Problems of Mathematical Physics and Analysis Mikhail Mikhaïlovich Lavrent'ev, Vladimir Gavrilovich Romanov, Serge Petrovich Shishatski_, 1986-12-31 Physical formulations leading to ill posed problems Basic concepts of the theory of ill posed problems Analytic continuation Boundary value problems for differential equations Volterra equations Integral geometry Multidimensional inverse problems for linear differential equations Inverse Problems in Partial Differential Equations David L. Colton, Richard E. Ewing, William Rundell, Society for Industrial and Applied Mathematics, 1990-01-01 *The*

One-Dimensional Heat Equation John Rozier Cannon, 1984-12-28 This is a version of Gevrey's classical treatise on the heat equations. Included in this volume are discussions of initial and/or boundary value problems, numerical methods, free boundary problems, and parameter determination problems. The material is presented as a monograph and/or information source book. After the first six chapters of standard classical material, each chapter is written as a self-contained unit except for an occasional reference to elementary definitions, theorems, and lemmas in previous chapters.

Elements of the Theory of Inverse Problems A. M. Denisov, 2014-07-24 The Inverse and Ill-Posed Problems Series is a series of monographs publishing postgraduate level information on inverse and ill-posed problems for an international readership of professional scientists and researchers. The series aims to publish works which involve both theory and applications in e.g. physics, medicine, geophysics, acoustics, electrodynamics, tomography, and ecology.

Inverse Problems in Scattering G.M.L. Gladwell, 1993-10-31 *Inverse Problems in Scattering* exposes some of the mathematics which has been developed in attempts to solve the one-dimensional inverse scattering problem. Layered media are treated in Chapters 1-6 and quantum mechanical models in Chapters 7-10. Thus Chapters 2 and 6 show the connections between matrix theory, Schur's lemma in complex analysis, the Levinson-Durbin algorithm, filter theory, moment problems, and orthogonal polynomials. The chapters devoted to the simplest inverse scattering problems in quantum mechanics show how the Gel'fand-Levitan and Marchenko equations arose. The introduction to this problem is an excursion through the inverse problem related to a finite difference version of Schrödinger's equation. One of the basic problems in inverse quantum scattering is to determine what conditions must be imposed on the scattering data to ensure that they correspond to a regular potential which involves Lebesgue integrable functions which are introduced in Chapter 9.

Methods of Inverse Problems in Physics Dilip N. Ghosh Roy, 1991-03-14 This interesting volume focuses on the second of the two broad categories into which problems of physical sciences fall: direct or forward and inverse or backward problems. It emphasizes one-dimensional problems because of their mathematical clarity. The unique feature of the monograph is its rigorous presentation of inverse problems from quantum scattering to vibrational systems, transmission lines, and imaging sciences in a single volume. It includes exhaustive discussions on spectral function, inverse scattering, integral equations of Gel'fand-Levitan and Marchenko, Povzner-Levitan and Levin transforms, Miller wave operators, and Krein's functionals. S-matrix and scattering data and inverse scattering transform for solving nonlinear evolution equations via inverse solving of a linear isospectral Schrödinger equation and multisoliton solutions of the KdV equation which are of special interest to quantum physicists and mathematicians. The book also gives an exhaustive account of inverse problems in discrete systems including inverting a Jacobi and a Toeplitz matrix which can be applied to geophysics, electrical engineering, applied mechanics, and mathematics. A rigorous inverse problem for a continuous transmission line developed by Brown and Wilcox is included. The book concludes with inverse problems in integral geometry, specifically Radon's transform and its inversion which is of particular interest to imaging scientists. This fascinating volume will interest

anyone involved with quantum scattering theoretical physics linear and nonlinear optics geosciences mechanical biomedical and electrical engineering and imaging research

Random Fields Estimation Alexander G. Ramm, 2005 This book contains a novel theory of random fields estimation of Wiener type developed originally by the author and presented here No assumption about the Gaussian or Markovian nature of the fields are made The theory constructed entirely within the framework of covariance theory is based on a detailed analytical study of a new class of multidimensional integral equations basic in estimation theory This book is suitable for graduate courses in random fields estimation It can also be used in courses in functional analysis numerical analysis integral equations and scattering theory

Mathematics of Computation 1943-1993: A Half-Century of Computational Mathematics Walter Gautschi, 1994 Proceedings of an International Conference held in Vancouver B C August 1993 to commemorate the 50th anniversary of the founding of the journal Mathematics of Computation It consisted of a Symposium on Numerical Analysis and a Minisymposium of Computational Number Theory This proceedings contains 14 invited papers including two not presented at the conference an historical essay on integer factorization and a paper on componentwise perturbation bounds in linear algebra The invited papers present surveys on the various subdisciplines covered by Mathematics of Computation in a historical perspective and in a language accessible to a wide audience The 46 contributed papers address contemporary specialized work Annotation copyright by Book News Inc Portland OR

Mathematics of Multidimensional Seismic Imaging, Migration, and Inversion N. Bleistein, J.K. Cohen, John W. Jr. Stockwell, 2013-11-22 In the last 40 years geophysicists have found that it is possible to construct images and even determine important physical characteristics of rocks that can yield information about oil and gas bearing structures in the earth To make these images and extract this information requires the application of an advanced understanding of the mathematical physics of wave propagation The oil and gas industry labels a major collection of the necessary seismic data processing methods by the name seismic migration This text is the first to treat many kinds of migration in a unified mathematical way The audience is mathematically oriented geophysicists or applied mathematicians working in the field of inverse scattering imaging The text can serve as a bridge between the applied math and geophysics community by presenting geophysicists with a practical introduction to advanced engineering mathematics while presenting mathematicians with a window into the world of the mathematically sophisticated geophysicist

Models and Methods of Magnetotellurics Mark N. Berdichevsky, Vladimir I. Dmitriev, 2010-07-15 Magnetotelluric methods are finding increasing applications for imaging electrically conductive structures below the Earth's surface in both industrial and academic research In Models and Methods of Magnetotellurics the authors provide a systematic approach to understanding the modern theory of ill posed problems which is essential to making confident meaningful interpretation of magnetotelluric and magnetovariational soundings The interpretation is conducted out in an interactive way including the hypotheses tests and successive partial inversions with priority of the tippers magnetic tensors and impedance phases which keeps out the

destructive static effects of near surface inhomogeneities The efficiency of the interpretation is exemplified by new geoelectric models of the Baikal rift zone and the Cascadian subduction zone

Optimal Control of Partial Differential Equations II: Theory and Applications K.-H. Hoffmann, W. Krabs, 2013-03-14

This volume contains the contributions of participants of the conference Optimal Control of Partial Differential Equations which under the chairmanship of the editors took place at the Mathematisches Forschungsinstitut Oberwolfach from May 18 to May 24 1986 The great variety of topics covered by the contributions strongly indicates that also in the future it will be impossible to develop a unifying control theory of partial differential equations On the other hand there is a strong tendency to treat problems which are directly connected to practical applications So this volume contains real world applications like optimal cooling laws for the production of rolled steel or concrete solutions for the problem of optimal shape design in mechanics and hydrodynamics Another main topic is the construction of numerical methods This includes applications of the finite element method as well as of Quasi Newton methods to constrained and unconstrained control problems Also very complex problems arising in the theory of free boundary value problems are treated Inally some contributions show how practical problems stimulate the further development of the theory in particular this is the case for fields like suboptimal control necessary optimality conditions and sensitivity analysis As usual the lectures and stimulating discussions took place in the pleasant atmosphere of the Mathematisches Forschungsinstitut Oberwolfach Special thanks of the participants are returned to the Director as well as to the staff of the institute

Inverse Problems in Wave Propagation Guy Chavent, George Papanicolaou, Paul Sacks, William Symes, 2012-12-06 Inverse problems in wave propagation concern extraction of information about distant structural features from the measurements of scattered waves Tasks of this nature arise in geophysics ocean acoustics civil and environmental engineering ultrasonic nondestructive testing biomedical ultrasonics radar astrophysics and other areas of science and technology The papers in this volume represent most of these scientific and technical topics together with fundamental mathematical investigations of the relation between waves and scatterers

40 Years In Mathematical Physics Ludvig Dmitrievich Faddeev, 1995-10-09 This is a collection of Prof L D Faddeev's important lectures papers and talks Some of these have not been published before and some have for the first time been translated from Russian into English The topics covered correspond to several distinctive and pioneering contributions of Prof Faddeev to modern mathematical physics quantization of Yang Mills and Einstein gravitational fields soliton theory the many dimensional inverse problem in potential scattering the Hamiltonian approach to anomalies and the theory of quantum integrable models There are also two papers on more general aspects of the interrelations between physics and mathematics as well as an autobiographical essay

Operator Theory and Differential Equations Anatoly G. Kusraev, Zhanna D. Totieva, 2021-01-13 This volume features selected papers from The Fifteenth International Conference on Order Analysis and Related Problems of Mathematical Modeling which was held in Vladikavkaz Russia on 15-20th July 2019 Intended for mathematicians specializing in operator

theory functional spaces differential equations or mathematical modeling the book provides a state of the art account of various fascinating areas of operator theory ranging from various classes of operators positive operators convolution operators backward shift operators singular and fractional integral operators partial differential operators to important applications in differential equations inverse problems approximation theory metric theory of surfaces the Hubbard model social stratification models and viscid incompressible fluids *Sobolev Spaces in Mathematics III* Victor Isakov, 2008-12-02

This volume marking the centenary of S L Sobolev's birth presents the latest the results on some important problems of mathematical physics The book contains two short biographical articles and unique archive photos of S Sobolev

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