<<分数维动力学>>

图书基本信息

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作者：塔拉索夫

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前言

Fractional calculus is a theory of integrals and derivatives of any arbitrary real （orcomplex） order. It has a long history from 30 September 1695, when the derivativeof order a = 1/2 was mentioned by Leibniz. The fractional differentiation and frac-tional integration go back to many great mathematicians such as Leibniz, Liouville,Grfinwald, Letnikov, Riemann, Abel, Riesz and Weyl. The integrals and derivativesof non-integer order, and the fractional integro-differential equations have foundmany applications in recent studies in theoretical physics, mechanics and appliedmathematics.　New possibilities in mathematics and theoretical physics appear, when the ordera of the differential operator Dxa or the integral operator Ixa becomes an arbitraryparameter. The fractional calculus is a powerful tool to describe physical systemsthat have long-term memory and long-range spatial interactions. In general, manyusual properties of the ordinary （first-order） derivative Dx are not realized for frac-tional derivative operators Da. For example, a product rule, chain rule and semi-group property have strongly complicated analogs for the operators D~a.　Most of the processes associated with complex systems have nonlocal dynamicsand it can be characterized by long-term memory in time. The fractional integrationand fractional differentiation operators allow one to consider some of those charac-teristics. Using fractional calculus, it is possible to obtain useful dynamical mod-els, where fractional integro-differential operators in the time and space variablesdescribe the long-term memory and nonlocal spatial properties of the complex me-dia and processes. We should note that close connections exist between fractionaldifferential and integral equations, and the dynamics of many complex systems,anomalous processes and fractal media.　There are many interesting books about fractional calculus, fractional differentialequations, and their physical applications. The first book dedicated specifically tothe theory of fractional integrals and derivatives, is the one by Oldham and Spanierpublished in 1974. There exists the remarkably comprehensive encyclopedic-typemonograph by Samko, Kilbus and Marichev, which was published in Russian in1987 and in English in 1993.

内容概要

Nonlinear Physical Science focuses on the recent advancesof fundamental theories and principles， analytical andsymbolic approaches， as well as computational techniques innonlinear physical science and nonlinear mathematics withengineering applications.

作者简介

作者：（俄罗斯）塔拉索夫（Vasily E.Tarasov） 丛书主编：罗朝俊 （瑞典）伊布拉基莫夫

书籍目录

章节摘录

插图：Statistical mechanics is the application of probability theory to study the dynam-ics of systems of arbitrary number of particles （Gibbs, 1960; Bogoliubov, 1960;Bogolyubov, 1970）. Equations with derivatives of non-integer order have many ap-plications in physical kinetics （see, for example, （Zaslavsky, 2002, 2005; Uchaikin,2008） and （Zaslavsky, 1994; Saichev and Zaslavsky, 1997; Weitzner and Zaslavsky,2001; Chechkin et al., 2002; Saxena et al., 2002; Zelenyi and Milovanov, 2004;Zaslavsky and Edelman, 2004; Nigmatullin, 2006; Tarasov and Zaslavsky, 2008;Rastovic, 2008））. Fractional calculus is used to describe anomalous diffusion, andtransport theory （Montroll and Shlesinger, 1984; Metzler and Klafter, 2000; Za-slavsky, 2002; Uchaikin, 2003a,b; Metzler and Klafter, 2004）. Application of frac-tional integration and differentiation in statistical mechanics was also consideredin （Tarasov, 2006a, 2007a） and （Tarasov, 2004, 2005b,a, 2006b, 2007b）. Fractionalkinetic equations usually appear from some phenomenological models. We suggestfractional generalizations of some basic equations of statistical mechanics. To ob-tain these equations, the probability conservation in a fractional differential volumeelement of the phase space can be used （Tarasov, 2006a, 2007a）. This element canbe considered as a small part of the phase space set with non-integer-dimension. Wederive the Liouville equation with fractional derivatives with respect to coordinatesand momenta. The fractional Liouville equation （Tarasov, 2006a, 2007a） is obtainedfrom the conservation of probability to find a system in a fractional volume element.This equation is used to derive fractional Bogolyubov and fractional kinetic equa-tions with fractional derivatives. Statistical mechanics of fractional generalizationof the Hamiltonian systems is discussed. Liouville and Bogolyubov equations withfractional coordinate and momenta derivatives are considered as a basis to derivefractional kinetic equations. The Vlasov equation with derivatives of non-integer or-der is obtained. The Fokker-Planck equation that has fractional phase space deriva-tives is derived from fractional Bogolyubov equation.

编辑推荐

《分数维动力学:分数阶积分在粒子、场及介质动力学中的应用》：Fractional Dynamics: Applications of Fractional Calculus to Dynamics of Particles,Fields and Media presents applications of fractional calculus, integral anddifferential equations of non-integer orders in describing systems with long-timememory, non-local spatial and fractal properties. Mathematical models of fractalmedia and distributions, generalized dynamical systems and discrete maps, non-local statistical mechanics and kinetics, dynamics of open quantum systems, thehydrodynamics and electrodynamics of complex media with non-local propertiesand memory are considered.This book is intended to meet the needs of scientists and graduate studentsin physics, mechanics and applied mathematics who are interested in electro-dynamics, statistical and condensed matter physics, quantum dynamics, complexmedia theories and kinetics, discrete maps and lattice models, and nonlineardynamics and chaos.Dr. Vasily E. Tarasov is a Senior Research Associate at Nuclear Physics Instituteof Moscow State University and an Associate Professor at Applied Mathematicsand Physics Department of Moscow Aviation Institute.