# The Sixth International Symposium on Applied Fractional Calculus

## ——In Celebration of the 70th Birthday of Prof. Virginia Kiryakova and the 60th Birthday of Prof. Shaher Momani

November 19, 2022
Beijing Jiaotong University, Beijing, China

**Sponsor**: Technical Committee on Fractional Order System and Control of Chinese Association of Automation

**Organizer**: Beijing Jiaotong University

# The Sixth International Symposium on Applied Fractional Calculus

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### Beijing Jiaotong University, Beijing, China (November 19, 2022)

The International Symposium on Applied Fractional Calculus was established in 2016. It mainly discusses the theory and application of fractional calculus, which is of great significance for promoting the practical optimization, control, and mechanics problems.

In 2022, the 6th International Symposium on Applied Fractional Calculus will be held in Beijing Jiaotong University and discussed by experts, scholars, and graduate students from many research institutes and universities. It is sponsored by Technical Committee on Fractional Order System and Control of Chinese Association of Automation and organized by Beijing Jiaotong University.

## Program Committee

- Prof. Yongguang Yu (Beijing Jiaotong University, Beijing, China)
- Prof. YangQuan Chen (University of California, Merced)
- Prof. Yong Wang (University of Science and Technology of China)

## Organizing Committee

- Prof. Yongguang Yu (Beijing Jiaotong University, Beijing, China)
- Prof. YangQuan Chen (University of California, Merced)
- Dr. Guojian Ren (Beijing Jiaotong University, Beijing, China)

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**Beijing Jiaotong University**

# Content

# Virtual Conference Announcement

The 6th International Symposium on Applied Fractional Calculus will be held online. It provides **VooV Meeting** to participators.

**Meeting Topic:** The Sixth International Symposium on Applied Fractional Calculus

**Meeting Time:** 2022/11/19 08:00-18:00 (UTC/GMT+08:00) China Standard Time - Beijing

**Live Stream URL:**

https://meeting.tencent.com/dm/1Onzl91mRJBd

**Meeting ID:** 414-509-769

本次会议为线上会议，请通过**腾讯会议**参会，会议信息如下：

**会议主题：**第六届应用分数阶微积分国际研讨会（北京交通大学）

**会议时间：**2022/11/19 08:00-18:00 (UTC/GMT+08:00) 中国标准时间-北京

**点击链接入会，或添加至会议列表：**

https://meeting.tencent.com/dm/1Onzl91mRJBd

**会议 ID：**414-509-769

| **Conference Program**<br>**2022, November 19**<br>**Tencent Meeting ID: 414-509-769** | | | | |
|---|---|---|---|---|
| **08:30-08:40 (UTC/GMT +8.00)** | **Opening Ceremony** | | | **Chair**<br>YangQuan Chen<br>Yong Wang<br>Yongguang Yu<br>Xiangyun Meng<br>Wei Su<br>Wei Hu<br>Xiaojing Wang |
| **Time** | **Chair** | **Reporter** | **School** | **Title** |
| **08:40-09:20 (UTC/GMT +8.00)** | YangQuan Chen | Bruce J. West | North Carolina State University | Complexity Synchronization |
| **09:20-10:00 (UTC/GMT +8.00)** | | Shaher Momani | University of Jordan | Back to Basics: The Role of Fractional Calculus in Predicting Coronavirus Behaviours |
| **10:00-10:40 (UTC/GMT +8.00)** | Yongguang Yu | Zuguo Yu | Xiangtan University | Some applications of fractal methods and fractional stochastic differential equations in geomagnetic data processing |
| **10:40-11:20 (UTC/GMT +8.00)** | | Zhigang zeng | Huazhong University of Science and Technology | 复杂系统的多稳定性理论研究 |
| **11:20-12:00 (UTC/GMT +8.00)** | Xiangyun Meng | Xiangcheng Zheng | Peking University | High-index saddle dynamics and solution landscape of space-fractional problems |
| **12:00-14:00 (UTC/GMT +8.00)** | **Lunch** | | | |

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|---|---|---|---|---|
| **14:00-14:40 (UTC/GMT +8.00)** | Yong Wang | YangQuan Chen | University of California Merced | Two triangles: Fractional Calculus/Inverse Power Law/Complexity and FC/Renormalization Group/Machine Learning |
| **14:40-15:20 (UTC/GMT +8.00)** | YangQuan Chen | Virginia Kiryakova | Bulgarian Academy of Sciences,Sofia ,Bulgaria | The game of fractional calculus with special fuctions |
| **15:20-16:00 (UTC/GMT +8.00)** | Wei Su | Huacheng Zhou | Central South university | Some recent results on boundary stabilization of fractional PDEs |
| **16:00-16:40 (UTC/GMT +8.00)** | Wei Hu | Chuang Li | Hainan University | Discussion on tuning method of tilt-integral-derivative controller and experimental validation |
| **16:40-17:10 (UTC/GMT +8.00)** | Xiaojing Wang | Guojian Ren | Beijing Jiaotong University | Fractional order systems modeling and analysis based on CTRW |
| **17:10-17:20 (UTC/GMT +8.00)** | **Closing ceremony** | | | |

# Introduction to Reporters and Talk Abstracts

## Report 1 (08:40-09:20 UTC/GMT +8.00)

**Title:** Complexity Synchronization

**Reporter:** Bruce J. West

**Talk Abstract:** Since the turn of the century Network Science and Complexity Theory have been growing dramatically and their nexus has led to profoundly different ways of thinking about physiology, health, disease, and rehabilitation from those based on Newtonian mechanics. The observational ubiquity of inverse power law spectra (IPLS) in complex phenomena entailed a theory for the dynamics capturing their fractal dimension and statistics. These and other properties, e.g., chaos and multifractality, are consequences of the complexity resulting from nonlinear dynamic networks collectively summarized for biomedical phenomena as the Network Effect (NE). The NE is often described by homogeneous scaling variables with power law scaling having index δ determined by the fractal dimension of the time series being a direct measure of the network's complexity. In this talk I will address the measurable consequences of the NE on time series generated by different parts of the brain, heart, and lung organ networks, which are directly related to their inter-network and intra-network interactions. Moreover, these same physiologic organ networks are known to generate multifractal time series, and I will show, using diffusion entropy analysis (DEA), that in addition they have scaling indices with quasiperiodic changes in complexity (scaling index) over time. Such time series are generated by different parts of the brain, as well as heart and lung organ networks, and the results do not depend on the coherence properties of time series but demonstrate a generalized synchronization of complexity. This high-order synchrony among the scaling indices of EEG, ECG and respiratory time series is governed by the quantitative interdependence of the multifractal behavior of the various physiological organs' network

dynamics. This consequence of the NE opens the door for an entirely general characterization of the dynamics of complex networks in terms of complexity synchronization (CS) independently of the scientific, engineering, or technological context. CS is a truly transdisciplinary effect.

**Biography:** Dr. Bruce J. West was the Chief Scientist in Mathematical and Information Science at the US Army Research Office (ARO), 1999-2021 (retired 7/1/21), with a PhD in Physics from the University of Rochester 1970. Over nearly 50-year career he has published 21 books, including most recently, Crucial Events (World Scientific, NJ, 2021); Fractional Calculus View of Complexity, Tomorrow's Science (CRC Press, Fl, 2016); Nature's Patterns and the Fractional Calculus (De Gruyer GmbH, Berlin, 2017). He has published over 350 scientific articles, essays and opinions in referred scientific journals garnering over 24K citations with an h-factor of 75. Before ARO Dr. West was Professor of Physics, University of North Texas, 1989-1999; Chair of the Department of Physics 1989-1993. He is a Fellow of the American Physical Society, elected in 1992 and of the American Association for the Advancement of Science, elected in 2012. He has multiple awards for his research including the Presidential Meritorious Rank Award 2012 (Obama) and the Presidential Distinguished Rank Award 2017 (Trump).

# Report 2 (09:20-10:10 UTC/GMT +8.00)

**Title:** Back to Basics: The Role of Fractional Calculus in Predicting Coronavirus Behaviours

**Reporter:** Prof. Shaher Momani

**Talk Abstract:** Recently, the entire world has witnessed an enormous upsurge in coronavirus pandemic (COVID-19 pandemic). Confronting such acute infectious disease, which have taken multiple victims around the world, has required from all specialists in all fields to devote their efforts for seeking effective treatment or even control its disseminate. In the light of this aspect, several novel fractional-order versions of SIR model or even its extensions have been proposed accordingly. These novel versions, which could be solved numerically with the help of using several numerical methods, have been established in view of several fractional-order differential operators such as Caputo, Caputo-Fabrizio, Caputo-Hadamard, etc. Lots of novel results related to the stability analysis and the basic reproductive number have been addressed for the proposed fractional-order COVID-19 model. Several numerical results have revealed the impactful of the fractional-order values on the established disease models. These results have confirmed that the proposed fractional-order COVID-19 models are better than that of classical one when such comparisons are performed between them and some real data collected from some infected society. This inference together with the cases predictions that could easily deduced from the proposed fractional-order models can allow primary decision makers and influencers to set the right plans and logic strategies that should be followed to face this pandemic. In this talk, several fractional-order COVID-19 models of our own part will be briefly considered with their analysis. These models, which were formulated in light of the continuous and discrete time, have confirmed their ability in predicting pandemic trends usefully. This assertion was supported by several numerical simulations and experimental results.

**Biography:** Prof. Shaher Momani received his B.Sc. in Mathematics from Yarmouk University in 1984, and his PhD Degree in Mathematics from the University of Wales

Aberystwyth in 1991, under the supervision of Professor Ken Walters, FRS. He started his teaching career at Mutah University in 1991 where he was subsequently promoted through the ranks. He also served as Associate Professor at Yarmouk University (2000-2001), Associate Professor at United Arab Emirates University (2001-2004), Professor at Qatar University (2006-2007) and a distinguished Professor at The University of Jordan (2009-present). Recently, he is a distinguished Professor and the Dean of College of Humanities and Sciences at Ajman University, UAE (2019-present).

Momani has been at the forefront of research in the field of Fractional Calculus in three decades and classified as one of the top ten Scientists in the World in this field for the period 2009-2013 according to Clarivate Analytics (formerly Thomson Reuters). He has authored or co-authored more than 450 peer-reviewed papers in international journals of high quality. He has been selected by Clarivate Analytics in its prestigious list of Highly Cited Researchers in Mathematics: 2014, 2015, 2016, and 2017. And in 2018, he has been selected by Clarivate Analytics in Cross-Field category to identify researchers with substantial influence across several fields during the last decade. Also, he has been selected by Clarivate Analytics in its prestigious list of The World's Most Influential Scientific Minds from 2014 to 2018.

Momani received many honors and international prizes including the Order of King Abdullah II Ibn Al Hussein for Excellence of the Second Class" for his Academic Contributions in Scientific Research (2016) and the Abdul Hameed Shoman Award for Arab Researchers (2019).

# Report 3 (10:00-10:40 UTC/GMT +8.00)

**Title:** Some applications of fractal methods and fractional stochastic differential equations in geomagnetic data processing

**Reporter:** Zuguo Yu

**Talk Abstract:** An important aim of solar-terrestrial physics is understanding the causes of geomagnetic activity in general and geomagnetic storms in particular. Earlier works in modelling the magnetosphere in the framework of self-organized criticality (SOC) motivated many recent studies on stochastic properties of the magnetosphere and related geomagnetic indices. These signatures may appear in the form of power law scaling in the probability distributions or in the power spectra. Fractal and multifractal approaches have been quite successful in extracting salient features of physical processes responsible for the near-Earth magnetospheric phenomena. The time series of indices AE and Bx at each station can be modelled as the solution of a fractional stochastic differential equation. In this talk, I introduce some applications of fractal methods and fractional stochastic differential equations in geomagnetic data processing.

**Biography:** 喻祖国，二级教授。1997 年复旦大学数学系博士毕业，1999 年中国科学院理论物理研究所博士后出站，曾全职在澳大利亚昆士兰理工大学从事研究工作 6 年（2000-2003，2005-2008）。现任湘潭大学副校长、“智能计算与信息处理”教育部重点实验室主任，是国务院政府特殊津贴专家、教育部创新团队负责人、教育部新世纪人才、湖南省“芙蓉学者计划”特聘教授，SCI 期刊 J. Nonlin. Math. Phys. 编委，SCI 期刊 Current Bioinformatics (IF: 4.850 for 2021, Q1)、Mathematics (IF: 2.592 for 2021, Q1) 的客座编委。喻祖国教授主要从事分形和相关方法, 及在生物与环境数据分析、复杂网络分析中的应用研究。先后获得中国高校科学技术二等奖、湖南省教学成果一等奖 3 项（1 项排名第 1）、湖南省自然科学二等奖 2 项（均排名第 1）和湖南青年科技创新奖杰出奖（单独）等教学科研奖励；主持国家重大研发计划课题、国家自然科学基金项目 6 项、教育部创新团队项目、霍英东青年基金项目等的研究。多年来在 Mol. Biol. Evol. (2020 IF:16.240)、Briefings in Bioinformatics (IF:13.994)、 Chaos Solitons & Fractals (IF: 9.922)、Environmental Pollution (IF: 9.988)、Mol. Ecol. Res. (IF: 8.678)、Bioinformatics (IF: 6.931)、Fuzzy Sets and Systems、Chaos、J. Chem. Phys.、Phys. Rev. E 等发表论文 170 余篇。

# Report 4 (10:40-11:20 UTC/GMT +8.00)

**Title:** 复杂系统的多稳定性理论研究

**Reporter:** 曾志刚

**Talk Abstract:** 多重平衡态共存是大多数复杂系统如物理系统、生物系统和工程系统等中普遍存在的现象。特别是，在递归神经网络的一些应用中（例如联想记忆），需要多个稳定的平衡点共存。因此，从理论和实践的角度来看，多稳定性分析具有重要意义。我们将概述作为影响平衡点数目的关键因素的各种系统模型和激活函数的层次结构，讨论多稳定性的主要分析方法，给出几类神经网络系统的多稳定性分析工作，展望进一步研究的一些具有挑战性但又有趣的问题。

**Biography:** 曾志刚，教授，国家杰出青年科学基金获得者，教育部长江学者特聘教授，图像信息处理与智能控制教育部重点实验室主任，IEEE Fellow。2003 年 6 月在华中科技大学获系统分析与集成博士学位。曾在香港中文大学和中国科技大学从事博士后研究。先后担任 IEEE Transactions on Neural Networks；IEEE Transactions on Cybernetics; IEEE Transactions on Fuzzy Systems; Cognitive Computation; Neural Networks; Applied Soft Computing; 自动化学报；控制工程；系统工程与电子技术；控制理论与应用的编委。曾获教育部高等学校科学研究优秀成果奖自然科学奖一等奖、湖北省自然科学一等奖、湖北省科技进步一等奖、国家科学技术进步奖二等奖等奖励。

# Report 5 (11:20-12:00 UTC/GMT +8.00)

**Title:** High-index saddle dynamics and solution landscape of space-fractional problems

**Reporter:** Xiangcheng Zheng

**Talk Abstract:** High-index saddle dynamics provides an effective means to compute the any-index saddle points and construct the solution landscape. We prove error estimates for Euler discretization of high-index saddle dynamics by resolving the difficulties such as the strong nonlinearity and the construction of the unstable space in the numerical scheme. Then we propose a fast algorithm for the variable-order spectral fractional Laplacian, which reduces the computational cost from O(M^2 ln M) to O(M ln^2 M) where M refers to the size of the problem. Based on this fast algorithm, we apply the high-index saddle dynamics to construct the solution landscape of space-fractional phase field problems and then compare the impacts of variable fractional order and variable coefficient from the point of view of the solution landscape.

**Biography:** 郑祥成，北京大学数学科学学院博士后，主要从事非局部模型和鞍点动力学等问题的理论与数值分析研究。近年在 SIAM 系列, IMA J. Numer. Anal., Inverse Problems, CMAME, J. Comput. Phys. 等发表论文近 70 篇。先后获批博士后国际交流引进项目、博士后科学基金特别资助、面上资助等。

# Report 6 (14:00-14:40 UTC/GMT +8.00)

**Title:** Two triangles: Fractional Calculus/Inverse Power Law/Complexity and FC/Renormalization Group/Machine Learning

**Reporter:** YangQuan Chen

**Talk Abstract:**

**Biography:** YangQuan Chen earned his Ph.D. from Nanyang Technological University, Singapore, in 1998. He had been a faculty of Electrical Engineering at Utah State University (USU) from 2000-12. He joined the School of Engineering, University of California, Merced (UCM) in summer 2012 teaching “Mechatronics”, “Engineering Service Learning” and “Unmanned Aerial Systems” for undergraduates; “Fractional Order Mechanics”, “Linear Multivariable Control”, “Nonlinear Controls” and “Advanced Controls: Optimality and Robustness” for graduates. His research interests include mechatronics for sustainability, cognitive process control (smart control engineering enabled by digital twins), small multi-UAV based cooperative multi-spectral “personal remote sensing”, applied fractional calculus in controls, modeling and complex signal processing; distributed measurement and control of distributed parameter systems with mobile actuator and sensor networks. He received Research of the Year awards from USU (2012) and UCM (2020). He was listed in Highly Cited Researchers by Clarivate Analytics in 2018, 2019 and 2020. His lab website is http://mechatronics.ucmerced.edu/

# Report 7 (14:40-15:20 UTC/GMT +8.00)

**Title:** The game of fractional calculus with special fuctions

**Reporter:** Virginia Kiryakova

**Talk Abstract:** In Fractional Calculus (FC), as in the (classical) Calculus, the notions of derivatives and integrals (of 1st, 2nd, etc. or arbitrary, incl. non-integer order) are basic and co-related. One of the most frequent approach in FC is to define first the integral of fractional order - say the Riemann-Liouville (R-L), and then by means of suitable integer-order differentiation operation,
applied outside or under its sign, a fractional derivative is defined - in the R-L sense, or in Caputo sense. In this lecture I try to give a short survey on a Generalized Fractional Calculus (GFC), as a theory of FC based on the use of Special Functions (SF). It was presented in details in my (already old) book (see below), in some first papers of 1986, etc. & recent years' ones.

The notion of "generalized operators of fractional integration (and differentiation)" goes back to the ideas and works of Shyam L. Kalla (1970-1980), who considered integral operators of FC with some arbitrary SF as kernels. From these ideas, I was motivated to develop a detailed strong theory of GFC with singular SF kernels with many applications in different areas of Analysis: Integral Transforms, Operational Calculus, Special Functions, Differential Equations, Analytic Functions), etc.

The core of this GFC is that our generalized integrals and derivatives of fractional multi-order are based on commuting m-tuple (m = 1, 2, 3,…) compositions of operators of the classical FC with power weights (the so-called Erdelyi-Kober (E-K) operators), but are represented in compact and explicit form by means of integral, integro-differential (R-L type) or differential-integral (C-type) operators, where the kernels are special functions of most general hypergeometric kind (Meijer G- and Fox H-functions). The use of the SF tools essentially simplifies the study and the use of these GFC operators (instead of hardly to treat repeated integrals) and allows to derive a long list of operational rules and particular cases. One can briefly mention the R-L, E-K, Saigo, Marichev-Saigo-Maeda operators (for m=1,2,3), the hyper-Bessel and Gelfond-Leontiev operators (for arbitrary m >1), etc.

With the revival of the FC as not only an exotic theory, and the recognition that the fractional order (FO) models can describe better the fractal nature or the world, the solutions of the FO differential and integral equations and systems gained their important place and became unavoidable tools. These are represented explicitly (when possible) in terms of the so-called Special Functions of Fractional Calculus (SF of FC). In our studies, the relations between GFC and SF of FC are two-fold and the topics benefit each other.

Once, SF are explored as kernel functions in GFC. On the other side, GFC theory yields new properties and classifications of the SF and gives hints to introduce new classes of SF of FC. We will focus on the multi-index Mittag-Leffler and Le Roy type functions studied in our works. Also, a unified approach is proposed to evaluate images of arbitrary SF under operators of GFC in the most general case.

**Few references** (by V. Kiryakova): - "Generalized Fractional Calculus and Applications", Longman Sci. & Techn., Harlow - J. Wiley & Sons Inc, N. York (1994); - The multi-index Mittag-Leffler functions as important class of special functions of fractional calculus, Computers and Math. with Appl. 59 (2010), 1885-1895, doi:10.1016/j.camwa.2009.08.025; - The special functions of fractional calculus as generalized fractional calculus operators of some basic functions, Computers and Math. with Appl. 59 (2010), 1128-1141, doi: 10.1016/j.camwa.2009.05.014; - Fractional calculus operators of special functions? - The result is well predictable!, Chaos Solitons Fractals 102 (2017), 2-15, doi: 10.1016/j.chaos.2017.03.006; - Generalized fractional calculus operators with special functions. In: Handbook of Fractional Calculus with Applications. Vol. 1: Basic Theory, Ch. 4, 87-110, De Gryuter, 2019, doi:10.1515/9783110571622-004; - A guide to special functions in fractional calculus, Mathematics 9, No 1 (2021), Art. 106, 35 pp., doi: 10.3390/math9010106.

**Biography:** ***Ed.-in-Chief of International Journals:***

„Fractional Calculus and Applied Analysis" (FCAA), WoS – Q1, https://www.springer.com/journal/13540

„Internat. Journal of Applied Mathematics" (IJAM), Scopus – Q3, http://www.diogenes.bg/ijam/

- ***Scientific Degrees and Affiliation:***

Dr.Sc. (2010), Ph.D. (1987), B.Sc. / M. Sc. (1975)

- ***Affiliation:***

Institute of Mathematics and Informatics (IMI) – Bulgarian Academy of Sciences (BAS), Sofia – Bulgaria; since 1975, currently – Full Professor / Prof. Emeritus

- ***Fields of Research:***

Mathematics, Topics – Mathematical Analysis: Special Functions, Fractional Calculus, Integral Transforms, Applications

- ***Awards:***

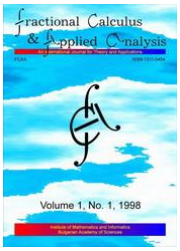
FDA Dissemination Award, Conf. FDA12 – Nanjing, China (2012);
Academic Prize for Mathematical Sciences of Bulgarian Academy of Sciences (1996);
Badge of Honour of the Town of Sofia (1994);
13$^{rd}$ Prize, Bronze Medal at 11$^{th}$ Internat. Math. Olympiad (Bucurest, 1969), etc.

- ***Specializations:***

Japan - Fukuoka Univ., Fukuoka (1997); Great Britain - Strathclyde Univ., Glasgow (1992);
Belarus – Belorussian State University, Minsk (1990)

• ***Scientific Publications and citations:***


**Scientific Surveys and Articles**: **Total number > 135**




**Monograph:** Virginia Kiryakova,
*Generalized Fractional Calculus and Applications*,
Longman (Harlow, UK) & John Wiley (N. York, USA), 1994; ISBN 0582219779; 978-0582219779, etc.

h–index = 31, by Google Scholar and Harzing's Publish or Perish: http://scholar.google.com/citations?user=HEuWjBAAAAAJ&hl=en ;
h–index = 19 (Clarivate analytic "Web of Science"); h–index = 17 (Elsevier "Scopus")

– V. Kiryakova's scientific works have been *cited by other authors more than 5800 times***.**

– Included in: *Stanford University List of Top 2% Scientists Worldwide*

• ***Expert Activities:***

Member of the Executive Body of National Science Fund – Bulgarian Ministry of Education and Science (2017-2021); Member of the Specialized Scientific Council for Mathematics at the State Attestation Commission of Bulgaria (2004-2010); Member of Scientific Council of Institute of Math. and Inform. (IMI) – BAS (2012-2024); Leader Project Coordinator and / or member for Res. Projects under Nat. Sci. Fund – Bulgaria; COST; and bilateral collaboration between Bulgarian, Serbian and Macedonian academies, etc.; Member of Edit. Boards of 10 Internat. Math. Journals abroad; Member and Chair of International Program Committees of Specialized Mathematical Conferences in Bulgaria and abroad, etc.

•***Visiting Professor*** (in universities, scientific institutions and intern. conferences abroad): Great Britain, USA, Japan, Kuwait, Holland, Lebanon, Tunisia, Spain, Portugal, Russia, Belarus, Poland, Italy, Serbia, Macedonia, Hungary, Germany, Turkey, UAE, China, etc.

• ***Social Activities:***

Member of Town (Municipality) Council of Sofia (1991 – 1995); etc.

# Report 8 (15:20-16:00 UTC/GMT +8.00)

**Title:** Some recent results on boundary stabilization of fractional PDEs

**Reporter:** Huacheng Zhou

**Talk Abstract:** The pioneering contribution of boundary stabilization problem of fractional partial differential equations (PDEs) can be tracked back to 2004 [Nonlinear Dynam., 38 (2004), 339-354], where all results were verified by simulations only and no rigorous mathematical proof was presented. In this talk, we give some recent results on boundary stabilization of fractional PDEs by utilizing the backstepping method, the active disturbance rejection control and sliding mode control. Based on the fractional Lyapunov method, Riesz basis method and fractional inequalites, we prove the closed-loop system to be Mittag-Leffler stable. As a result, we completely resolve, from a theoretical perspective, two long-standing unsolved mathematical control problems raised in [Nonlinear Dynam., 38(2004), 339-354].

**Biography:** 周华成，中南大学教授、博导。主要从事偏微分方程控制理论研究与抗扰控制研究。曾获中国科学院院长特别奖。学术成果发表在《IEEE Trans. Automat. Control》，《Automatica》，《SIAMJ. Control Optim.》，《ESAIM Control Optim. Calc. Var.》，《J. Differential Equations》，《Eur. J. Control》，《Internat. J. Control》，《Internat. J. Robust Nonlinear Control》，《J. Franklin Inst.》，《J.Math. Anal. Appl.》，《Nonlinear Dynamics》，《Nonlinear Analysis》等享有较高国际学术声誉的数学和控制领域主流刊物。担任 IEEE TAC, Automatica, SICON, COCV, MCSS, IJRNC, IJC, SCL, JFI, ND, ISA Transaction, IET CTA, 《中国科学:信息科学》, IEEE TIE, IEEE TCST, TIMC, FCAA, AMM, AMC 等 30 余个杂志的审稿人并多次被多个期刊(如 SCL, JFI 等)评为杰出审稿人(outstanding reviewer)。

# Report 9 (16:00-16:40 UTC/GMT +8.00)

**Title:** Discussion on tuning method of tilt-integral-derivative controller and experimental validation

**Reporter:** 李创

**Talk Abstract:**

**Biography:**

# Report 10 (16:40-17:10 UTC/GMT +8.00)

**Title:** Fractional order systems modeling and analysis based on CTRW

**Reporter:** Guojian Ren

**Talk Abstract:** The continuous-time random walk (CTRW) has been widely adopted to analyses standard and anomalous diffusion. Some fractional order compartment models have been derived by considering the governing equations from the generalized CTRW with waiting times moderating transitions between compartments. In our study, a fractional order model for rumor spreading in mobile social networks (MSNs) is derived from an underlying physical stochastic process, which can be regarded as a heterogeneous-network-based fractional order epidemic model. In the model, the fractional derivative appears because of the time for denying the rumor is power law distributed. Then, the basic reproduction number depended on the fractional derivative order is calculated. Also, starting from two stochastic processes of the waiting time and the step length, time-fractional space-fractional diffusion, time-fractional reaction diffusion and fractional-order diffusion can be naturally introduced into SIR (S-susceptible, I-infectious, R-recovered) epidemic models, respectively.

**Biography:** Guojian Ren is a lecturer at the School of Mathematics and Statistics, Beijing Jiaotong University. He obtained a doctorate degree from Beijing Jiaotong University in 2019. The current main research direction is fractional calculus, fractional Brownian motion, complex network and distributed coordination control. Published 30 papers in journals such as Nonlinear Dynam. Appl. Math. Comput., Inform. Sciences, Frac. Calc. Appl. Anal. and IET Control Theory A.