第六届反演问题计算方法及其应用国际会议
会议指南

The Sixth International Workshop on Computational Inverse Problems and Applications



主办单位：中国科学院地质与地球物理研究所

Institute of Geology and Geophysics,

Chinese Academy of Sciences

承办单位：深圳北理莫斯科大学

Shenzhen MSU-BIT University

国立莫斯科大学

Moscow State University

广东·深圳

Shenzhen, Guangdong Province, China

22-26, July, 2022

Content

1. Organizational structure and related instructions

Chairman

Yanfei Wang (yfwang@mail.iggcas.ac.cn)
(Institute of Geology and Geophysics, Chinese Academy of Sciences)

Scientific Committee

Chairman:
Yaxiang Yuan
(Academy of Mathematics and Systems Science, Chinese Academy of Sciences)

Committee members：
Gang Bao (Zhejing University)
Jin Cheng (Fudan University)
Jijun Liu (Southeast University)
Sergey Pereverzyev (Austrian Academy of Sciences)
A. Yagola (Moscow State University)
Bo Zhang
(Academy of Mathematics and Systems Science, Chinese Academy of Sciences)
Jun Zou (The Chinese University of Hong Kong)
Yanfei Wang
(Institute of Geology and Geophysics, Chinese Academy of Sciences)

Organizing Committee

Director：
Yanfei Wang
(Institute of Geology and Geophysics, Chinese Academy of Sciences)

Members：
A. Yagola
(Moscow State University)
Zhongxia Zhou
(Institute of Geology and Geophysics, Chinese Academy of Sciences)
Ye Zhang
(Shenzhen BIT-MSU University)

Scope of the conference

The field of inverse problems has existed in many branches of earth sciences, physical sciences, engineering and mathematics for a long time. Inverse problems are typically ill-posed. In recent years, different inverse problems in frontiers of sciences appear. Standard methods for inverse problems are regularization methods. In addition, optimization methods are widely used in other science and engineering fields, for example, big data and intelligent computing, geophysical prospecting, transportation, biology, communication and image

processing. Meanwhile, optimization methods have also been applied in computational inversion applications.

We sincerely welcome experts, professors and students from all over the world to participate in the Sixth International Workshop on Computational Inverse Problems and Applications held at Shenzhen MSU-BIT University, Shenzhen, Guangdong Province. Let's exchange and cooperate to promote the further development of inverse problems and their applications.

The conference includes but not limited to the following topics:

- Research on inverse problems
- Regularization methods
- Optimization methods
- Non-standard regularization methods
- Inverse problems in Geophysics
- Big data and artificial intelligence
- Applications in frontiers of science and engineering

Invited speakers:

Yaxiang Yuan, Professor, Institute of Computational Mathematics and Scientific/Engineering Computing, Chinese Academy of Sciences, China
Gang Bao, Professor, Zhejiang University, China
Jin Cheng, Professor, Fudan University & Shanghai Key Laboratory of Contemporary Applied Mathematics, China
S. I. Kabanikhin, Professor, Russian Academy of Sciences, Russia
G. M. Kuramshina, Professor, Lomonosov Moscow State University, Russia
Peijun Li, Professor, Purdue University, USA
Jijun Liu, Professor, Southeast University, China
D. Lukyanenko, Professor, Lomonosov Moscow State University, Russia
G. Nakamura, Professor, Hokkaido University, Japan
Ting Wei, Professor, Lanzhou University, China
Dinghua Xu, Professor, Zhejiang Sci-Tech University, China
Jingzhi Li, Professor, Southern University of Science and Technology, China
Yukun Guo, Harbin Institute of Technology, China
Dinghua Xu, Professor, Zhejiang Sci-Tech University, China
A. G. Yagola, Professor, Lomonosov Moscow State University, Russia
Bo Zhang, Professor, Academy of Mathematics and System Sciences, Chinese Academy of Sciences, China
J. Zou, Chinese University of Hong Kong, Hong Kong
Maxim Shishlenin, Novosibirsk State University, Novosibirsk, Russia
Zhenyu Zhao, School of Mathematics and Statistics, Shandong University of Technology, China

Shousheng Luo, School of Mathematics and Statistics, Henan University
Alexey Shcheglov, Shenzhen MSU-BIT University
Guozhi Dong, Central South University, China

Daily Schedule

Date	Content
July 22, 8:30 (AM) – 6:00 (PM)	Registration
July 22, 6:30 (PM)	Welcome Reception Dinner
July 23-24	Lectures
July 25	Lectures; panel discussion
July 26	Departure

Registration fees

For the regular attendees:150 US dollars (RMB:1000Yuan), for students:100 US dollars (RMB:800Yuan).

Accommodation

Please bear the expenses all by oneself, but we can provide reservation service. For standard room: 350Yuan/day, for advanced suite: 500Yuan/day. There are different advanced suites. For details, please consult the Conference Secretariat.

Apply for a visa

Please contact Prof. Yanfei Wang (yfwang@mail.iggcas.ac.cn) for the invitation letters and other information (Prof. Ye Zhang, ye.zhang@smbu.edu.cn).

Contact

Conference affairs：

Li-mei Xu: (+86) 0755-283-231-34

Hai-e Long: (+86) 188-4645-4246

Meeting-place: Demo Hall, library (图书馆)

Recommended hotel 1: The Coli Hotel (深圳中海凯骊酒店), 2.8km from SMBU

http://www.thecolihotelsz.com/publisher/EN-CONTACT.html

168 Dayun Road, Dayun new town, Longgang District, Shenzhen

TEL：+86 0755 8989 9888 FAX：+86 0755 8989 0999

Recommended hotel 2: Campus apartment (校园教师公寓)

酒店名称	标准	地址	联系人及电话
深圳龙岗珠江皇冠假日酒店	5星	深圳龙岗区龙翔大道9009号 协议价：550元/间，单早 600元/间，双早	杨经理： 0755-36900628 13725599025
中海凯骊酒店	5星	深圳市龙岗区大运路体育新城168号 协议价：588元/间（高级大床/双床房），双早（周末558元/间） 688元/间（豪华大床房），双早	前台：0755-89899888 黎经理：13590265834
深圳皇朝印象酒店	准4星	深圳市龙岗区黄阁路190号 优惠价：308元/间，双早	前台：0755-89678888 朱经理：18938095900
维也纳国际酒店(深圳龙岗天安数码城店)	准4星	深圳龙岗区清林路中国邮政代办所路口右侧50米 优惠价：298元/间,双早	前台：0755-89566088 王经理：13556806089
维也纳国际酒店（大运中心店）	准4星	深圳市龙岗区龙翔大道4028号，优惠价：298元/间，双早	前台：0755-89909898 凌经理：13302313166
东莞大运城邦雅乐轩酒店	高档型	东莞凤岗镇清林路西大运城邦 （预定时说明学校名称可享优惠）	前台：0769-89196668 黄经理：15914164035
蓝图花园酒店	普通	深圳市龙岗区如意路283号-龙翔大道交汇处 标间：186 元/间，不含早	前台：0755-89619899 刘经理：15875516781
华轩里酒店	高档型	深圳市龙岗区龙城街道爱联社区华讯商厦 协议价：349元/间（商务大床房），双早 359元/间（商务双人房），双早 379元/间（行政大床房），双早	幸经理： 15012490956 19928793126

Other hotels

深圳北站（龙华）——学校

公交E7路（7:10-23:59，约30分钟/趟）	E7路「深圳北站」上车（义乌小商品市场方向）→「信息学院站」下车→打车到校
地铁5号线→地铁3号线	地铁「深圳北站」乘坐5号线（往黄贝岭方向）→「布吉站」下车，转3号线（双龙方向）→「大运站」下车→打车到校（★推荐）
	或 地铁「大运站」C出口步行约200米至「大运地铁接驳站」公交站→M316路（7:00-20:45，约45分钟/趟）4站「国际自行车赛场站」下车→步行约110米至永久校区

From Shenzhen Railway Station to MSU-BIT (SMBU)

机场——学校

机场专线A4线（6:00-20：40，约30分钟/趟）	A4线「信息学院站」下车→打车到校（★推荐）
	A4线「信息学院站」下车→步行约620米至对面的「信息学院②站」→乘802路或M316路1站至（7:00-20:45，约45分钟/趟）「国际自行车赛场」下车→步行约110米至永久校区
地铁11号线→地铁3号线	地铁「机场站」乘坐11号线（往福田方向）→「福田站」下车，转3号线（往双龙方向）→「大运站」下车→打车到校

From Shenzhen Airport Station to MSU-BIT (SMBU)

2. Conference Agenda

Friday, 22th July, 2022			
Time	Agenda	Location	Note
9:00 - 22:00	Register	Hotel hall (中海凯骊酒店大厅)	
14:00 -15:30	Scientist public talk “Big data and Optimization” (Speaker: Yaxiang Yuan, Academician, Chinese Academy of Sciences)	Tencent room: 304-819-383 https://meeting.tencent.com/dm/F5h9iAJO6qoJ	
18:30 - 21:00	"ICE break"	Canteen 1, 2nd floor, buffet (1 食堂 2 楼)	
Saturday, 23th July, 2022			
Time	Agenda	Location	Note
07:00 - 08:45	Breakfast	Hotel hall (中海凯骊酒店大厅)	
08:45	Collective travel to the meeting rooms		
09:00 - 09:10	Violin Quartet	Library 1st floor	Chair: Ye Zhang
09:10 - 09:25	The opening ceremony 1. Speech by the rector of SMBU (5 mins) 2. Speech by the ICIAM president: Yaxiang Yuan (5 mins) 2. Speech by the conference chairman (5 mins)	Library 1st floor	Chair: Yanfei Wang
09:25 - 9:35	Group photo	In front of Library	Chair: Ye Zhang
09:45 - 10:15	Plenary Lecture (Speaker: Gang Bao, Zhejiang University)	Library 1st floor	Chair: Yaxiang Yuan
10:15 - 10:45	Plenary Lecture (Speaker: Jin Cheng, Fudan University) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	
10:45 - 11:00	Break	Library 1st floor	

11:00 - 11:30	Plenary Lecture (Speaker: J. Zou, Chinese University of Hong Kong) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	Chair: Jin Cheng
11:30 - 12:00	Plenary Lecture (Speaker: Sergey Kabanikhin, Russian Academy of Sciences) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	
12:00 - 14:00	Lunch	Canteen 1, 2nd floor, buffet (1 食堂 2 楼)	
14:00 - 14:30	Plenary Lecture (Speaker: Gen Nakamura, Hokkaido University) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	Chair: Xiaodong Liu
14:30 - 15:00	Plenary Lecture (Speaker: A. G. Yagola, Moscow State University) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	
15:10 - 15:40	Plenary Lecture (Speaker: Tingwei, Lanzhou University) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	
15:40 – 15:50	Break	Library 1st floor	
15:50 - 16:20	Plenary Lecture (Speaker: Dinghua Xu, Zhejiang Sci-Tech University/ Shanghai University of Finance and Economics) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	Chair: Hua Zhang
16:20 - 16:50	Plenary Lecture (Speaker: Jingzhi Li, Southern University of Science and Technology)	Library 1st floor	
16:50 - 17:20	Plenary Lecture (Speaker: Yukun Guo, Harbin Institute of Technology)	Library 1st floor	
17:20 – 17:45	Invited Lecture (Speaker: Wen Zhang, East China University of Technology)	Library 1st floor	Chair: Zewen Wang
17:45 - 18:10	Invited Lecture (Speaker: Tianqi Wang, Chinese Academy of Sciences)	Library 1st floor	

18:10 - 18:35	Invited Lecture (Speaker: D. Chaikovskii, SMBU)	Library 1st floor	
18:50 - 21:00	Banquet	Aolin Hotel (奥林宾馆)	
Sunday, 24th July, 2022			
Time	Agenda	Location	Note
07:00 - 08:30	Breakfast	Hotel hall (中海凯骊酒店大厅)	
08:30	Collective travel to the meeting rooms		
09:00 - 09:30	Plenary Lecture (Speaker: Bo Zhang，Chinese Academy of Sciences) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	Chair: Jijun Liu
09:30 - 10:00	Plenary Lecture (Speaker: Peijun Li, Purdue University) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	
10:00 - 10:30	Plenary Lecture (Speaker: Maxim Shishlenin) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	
10:30 - 10:50	Break	Library 1st floor	
10:50 - 11:20	Plenary Lecture (Speaker: Jijun Liu, Southeast University) (online, zoom)	Library 1st floor	Chair: Bo Zhang
11:20 - 11:50	Plenary Lecture (Speaker: Zhengyu Zhao, Shandong University of Technology) (online, zoom)	Library 1st floor	
12:00 - 14:00	Lunch	Canteen 1, 2nd floor, buffet (1 食堂 2 楼)	
14:00 - 14:30	Plenary Lecture (Speaker: D. Lukyanenko, Moscow State University) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	Chair: Dinghua Xu

14:30 - 15:00	Plenary Lecture (Speaker: Shousheng Luo, Henan University)	Library 1st floor	
15:00 - 15:30	Plenary Lecture (Speaker: Gulnara Kuramshina, Lomonosov Moscow State University) (online, zoom)	Library 1st floor Zoom room: Zoom ID: 462 476 1414 Password: 777777	
15:30 - 15:50	Break	Library 1st floor	
15:50 - 16:20	Plenary Lecture (Speaker: A. Shcheglov, SMBU)	Library 1st floor	Chair: Yong Chen
16:20 - 16:50	Plenary Lecture (Speaker: Guozhi Dong, Central South University)	Library 1st floor	
Parallel Sessions			
16:50 - 17:15	Invited Lecture (Speaker: Wenlong Zhang, Southern University of Science and Technology)	Library 1st floor	Chair: Yukun Guo
17:15 - 17:40	Invited Lecture (Speaker: Haifan Chen, Hunan Normal University)	Library 1st floor	
17:40 - 18:05	Invited Lecture (Speaker: Zhidong Zhang, Sun Yat-sen University)	Library 1st floor	
17:00 - 17:25	Invited Lecture (Speaker: Chen Xu, SMBU)	Teaching building 1, Room 113	Chair: Rongfang Gong
17:25 - 17:50	Invited Lecture (Speaker: Dehan Chen, Central China Normal University)	Teaching building 1, Room 113	
17:50 - 18:05	Closing ceremony	Library 1st floor	Ye Zhang /Yanfei Wang

18:10 - 20:30	Dinner	Canteen 1, 2nd floor, buffet (1 食堂 2 楼)	
Monday, 25th July, 2022			
Time	Agenda	Location	Note
07:00-09:00	Breakfast	Hotel hall (中海凯骊酒店大厅)	
09:00	Collective travel to Huawei		
10:00 - 12:00	Huawei cultural exhibition		
12:00 - 14:00	Lunch	Huawei	
14:00 - 18:00	Discussion		
18:00 - 21:00	Dinner	Canteen 1, 2nd floor, buffet (1 食堂 2 楼)	
Friday, 26th July, 2022			
Time	Agenda	Location	Note
07:00 - 17:00	Departure (Collection depends on time of the concentration)		

3. CIPA2022 Presentations

Plenary Lectures (alphabetical order of surnames)

Title: Solving the Calderon problem

Author: Gang Bao

Affiliation: Zhejiang University

Title: The Inverse Contact Problems in Elasticity

Author: Jin Cheng

Affiliation: School of Mathematical Sciences, Fudan University & Shanghai Key Laboratory of Contemporary Applied Mathematics

Abstract:

In elasticity, the problems of describing the local stress and deformation of two contact objects under pressure are referred as contact problems. The contact problems widely appear in many branches of engineering, such as Bearing, CAM mechanism, gear, hardness tester, rolling mill roll, bridge support and rigid head etc. The contact problem used to be a very difficult problem for applied mathematicians and mechanics.

In practice, it is difficult or impossible to observe some quantities, such as the stress distribution on the contact surface and contact surface in some scenarios. Therefore, how to construct other information from the observed data on the elastic body becomes important both in theoretical and practical sense. In this talk, we will present a class of inverse problems of determining the stress distributions and contact surfaces from boundary displacement data on the non-contact domain of the elastomer. It is proved that the observed data can uniquely determine the unknown function. We show that this problem is a severely ill-posed problem. By using the method of analytic continuity, we prove that this problem has certain conditional stability, which provides a theoretical guarantee for the construction of stable numerical algorithms. At the same time, in order to obtain accurate measurement data, we propose a method of using a large amount of data in exchange for measurement accuracy.

Talk title: First-order conditions for the optimal control of learning-informed nonsmooth PDEs

Author: Guozhi Dong

Affiliation: Central South University

E-mail: guozhi.dong@csu.edu.cn

Abstract:

In this talk we study the optimal control of a class of semilinear elliptic partial differential equations which have nonlinear constituents that are only accessible by data and are approximated by nonsmooth ReLU neural networks. The optimal control problem is studied in detail. In particular, the existence and uniqueness of the state equation are shown, and continuity as well as directional differentiability properties of the corresponding control-to-state map are established. Based on approximation capabilities of the pertinent networks, we address fundamental questions regarding approximating properties of the learning-informed control-to-state map and the solution of the corresponding optimal control problem. Finally, several stationarity conditions are derived based on different notions of generalized differentiability.

Talk title: Study of bioluminescence tomography based on a new time-dependent coupled diffusion equation

Author: Rongfang Gong

Affiliation: College of Mathematics, Nanjing University of Aeronautics and Astronautics，China

E-mail: grf_math@nuaa.edu.cn

Abstract:

In this talk, we consider inverse source problems arising in bioluminescence tomography (BLT). Mathematically, BLT is an under-determined inverse source problem which leads to no solution uniqueness. Particularly, one cannot distinguish between a strong source over a small region and a weak source over a large region. Therefore, it is particularly important to know the support Ω_s of the underlining light source p_* so that its strength could be reconstructed accurately. In the literature, Ω_s is assumed to be given. Practically, we only get an approximation Ω_a of it, known from some a priori information. The accuracy of Ω_a affects largely the one in approximate solutions of p_*. Therefore, in this talk, a new time-dependent coupled model is proposed motivated by the solution uniqueness. Some theoretical and numerical results are reported for the verification of the new model and methods.

Talk title: Solving inverse scattering problems by the Fourier-Bessel expansion and direct imaging

Author: Yukun Guo

Affiliation: School of Mathematics, Harbin Institute of Technology, China

E-mail: ykguo@hit.edu.cn

Abstract:

This talk is concerned with the inverse acoustic scattering problems by an obstacle or a cavity with a sound-soft or a sound-hard boundary. A direct imaging method relying on the boundary conditions will be proposed for reconstructing the shape of the obstacle or cavity. First, the scattered fields are approximated by the Fourier-Bessel functions with the measurements on a closed curve. Then, the indicator functions are established by the superpositions of the total fields or their derivatives to the incident point sources. We prove that the indicator functions vanish only on the boundary of the obstacle or cavity. Numerical examples will also be presented to demonstrate the effectiveness of the method.

Acknowledgement: This work is supported by the NSFC grants 12171200 and 11971133.

References:

[1] D. Zhang, Y. Wu, Y. Wang and Y. Guo. A direct imaging method for the exterior and interior inverse scattering problems. *Inverse Problems and Imaging*, 2022, doi:10.3934/ipi.2022025

[2] D. Zhang, F. Sun, Y. Ma and Y. Guo, A Fourier-Bessel method with a regularization strategy for the boundary value problems of the Helmholtz equation, J. Comput. Appl. Math., 368, 112562, 2020.

Talk title: Continuation problems: Theory and Numerics

Authors: Sergey Kabanikhin, Maxim Shishlenin

Affiliation: Sobolev Institute of Mathematics, Institute of Computational Mathematics and Mathematical Geophysics, Novosibirsk, Russia

E-mails: ksi52@mail.ru, mshishlenin@ngs.ru

Abstract:

We consider several numerical approaches for parameters identification of the medium. One of this is based on the continuation problems of physical fields with the data on the part of the boundary [1,2,3], which arise in Geophysics, tomography, in problems of protection of nuclear reactors. The second is the method based on the conservation laws and the solution of the coefficient inverse problems.

Continuation problems are ill-posed and we formulate this problems in the form of operator equation Aq=f, for which the minimization of the objective functional and the method of singular value decomposition [2,3] are applied.

We study the properties of the operator A and the algorithm of minimization of functional $J(q)=\|Aq—f\|^2$ by the conjugate gradient method. In series of numerical experiments are shown that it allows us to recover the boundary conditions on the inaccessible part of the boundary, as well as

to obtain information about inhomogeneities (the number, location, approximate volume) located in the region of inaccessibility.

References:

[1] V. Isakov, S. Kindermann. Subspaces of stability in the Cauchy problem for the Helmholtz equation

Methods and Applications of Analysis 18 (1), 1-30.

[2] S. I. Kabanikhin, Y. S. Gasimov, D. B. Nurseitov, M. A. Shishlenin, B. B. Sholpanbaev and S. Kasenov. Regularization of the continuation problem for elliptic equations. Journal of Inverse and Ill-Posed Problems. 2013. 21(6). Pp. 871-884.

[3] Kabanikhin S.I, Shishlenin M.A., Nurseitov D.B., Nursetova A.T., Kasenov S.E. Comparative analysis of methods for regularizing an initial boundary value problem for the Helmholtz equation. Journal of Applied Mathematics. 2014. Vol. 2014, 7 pages

Talk title: Inverse Problems of Vibrational Spectroscopy: Applications.

Author: Gulnara Kuramshina

Affiliation: Lomonosov Moscow State University, Russia, Moscow

Abstract:

Many problems of physical chemistry belong to the class of inverse problems, in which from known experimental data of the object we need to determine some of its properties based on a certain model connecting these properties with measured characteristics. Inverse problems typically lead to mathematical models that are not well-posed in the sense of Hadamard, i.e. to the ill-posed problems. This means that they may not have a solution in the strict sense, solutions may not be unique and/or may not depend continuously on the input data A number of different mathematical problems arise in the data processing of experimental data obtained by means of vibrational (infrared and Raman) spectroscopy. The most important is the so-called inverse vibrational problem of determining parameters of the molecular force field (force constants) from given experimental data (vibrational frequencies, isotope frequency shifts, Coriolis constants, centrifugal distortion constants, etc.). The accumulation of data on force constants is necessary for prediction of spectra and other physicochemical properties of the bulky compounds not yet investigated which are too large for accurate quantum mechanical calculations.

The mathematical problem of calculating molecular force fields within the general approximation of small vibrations (harmonic model) is an ill-posed problem and it does not satisfy any of the three well-

posedness conditions (existence of solution, its uniqueness and stability to perturbations in input data). In most cases, the main difficulty is non-uniqueness of solution. Different algorithms based on the theory of regularization of nonlinear ill-posed problems have been proposed for solving this problem and finding the sets of force constants [1]. In our strategy the stabilizing matrix $F0$ is chosen as a result of quantum mechanical calculations, and thus we search for matrix F which is the nearest by the chosen Euclidean norm to the given *ab initio* $F0$. The optimized solution is referred to as *Regularized Quantum Mechanical Force Field* (RQMFF). New numerical algorithm for the calculation of scale factors for the molecular force fields expressed in Cartesian coordinates is developed and implemented as a part of the software package SPECTRUM [1]. The importance of large molecular systems (biological objects, polymers, giant aggregates etc.) stimulates the development of special approaches for the describing their physicochemical properties such as molecule geometry, vibrational frequencies, and thermodynamic functions, etc. Fast growing computational resources and numerical methods lead to the great advantage of modern methods of quantum chemistry for the solving many problems of structural chemistry in application to the large molecular systems. But the accurate calculations of the large molecular systems consisting of a few hundred atoms are still limited by the dimensions of systems because the purely *ab initio* methods require very large computational resources. One of possible approaches in such cases is to compose the matrix of force constants of bulky molecules from separate fragments corresponded to the smaller size units of force constants calculated as the regularized quantum mechanical force field (RQMFF) or using the new algorithm for scaled quantum mechanical force field (RSQMFF) in Cartesian coordinates [4]. Results obtained within this approach will be demonstrated for some bulky systems, biomolecules and their associates.

References:

1. A.G.Yagola, I.V.Kochikov, G.M.Kuramshina, Yu.A.Pentin. *Inverse problems of Vibrational Spectroscopy*.

VSP. Zeist, The Netherlands, 1999, De Gruyter, 2014.

2. I.V.Kochikov, G.M.Kuramshina, A.V.Stepanova. *Int. J. Quant. Chem.* **109,** 28-33 (2009).

3. I.V.Kochikov, A.V.Stepanova, G.M.Kuramshina. *Struct. Chem.* **30** (2), 605-614 (2019).

4. I.V.Kochikov, A.V.Stepanova, G.M.Kuramshina. *Molecules* Volume 27, Issue 2, 427-451 (2022).

Talk title: Determining a random Schrödinger operator: both potential and source are random

Author: Jingzhi Li

Affiliation: Department of Mathematics, Southern University of Science and Technology (SUSTech)

E-mail: li.jz@sustech.edu.cn

Abstract:

We present an inverse scattering problem associated with a Schrödinger system where both the potential and source terms are random and unknown. The well-posedness of the forward scattering problem is first established in a proper sense. We then derive two unique recovery results in determining the rough strengths of the random source and the random potential, by using the corresponding far-field data. The first recovery result shows that a single realization of the passive scattering measurements uniquely recovers the rough strength of the random source. The second one shows that, by a single realization of the backscattering data, the rough strength of the random potential can be recovered. The ergodicity is used to establish the single realization recovery. The asymptotic arguments in our study are based on techniques from theory of pseudodifferential operators and microlocal analysis.

References:

[1] Jingzhi Li, Hongyu Liu and Shiqi Ma, Determining a Random Schrödinger Operator: Both Potential and Source are Random, Communications in Mathematical Physics, Vol. 381, No. 2 pp. 527-556, 2021

Talk title: Inverse random potential scattering for elastic waves

Author: Peijun Li

Affiliation: Department of Mathematics, Purdue University, USA

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Abstract:

This talk is concerned with the inverse elastic scattering problem for a random potential. Interpreted as a distribution, the potential is assumed to be a microlocally isotropic Gaussian random field whose covariance operator is a classical pseudo-differential operator. Given the potential, the direct scattering problem is shown to be well-posed in the sense of distributions by studying the equivalent Lippmann-Schwinger integral equation. For the inverse scattering problem, we demonstrate that the microlocal strength of the random potential can be uniquely determined with

probability one by a single realization of the high frequency limit of the averaged scattered wave. The analysis employs the integral operator theory, the Born approximation in the high frequency regime, the microlocal analysis for the Fourier integral operators, and the ergodicity of the wave field.

Talk title: On stability and regularization for data-driven solution of parabolic inverse source problems

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Abstract:

The inverse source problems for diffusion process are of great importance, with the aim of recovering the internal source by some extra information about the physical field. There already exist considerable work on these topics including the regularizing schemes as well as the recovering scheme. In this talk, we will consider an inverse problem of recovering the spatial dependent ingredient of the internal source from final measurement data based on the neural network framework, where both the unknown source and the temperature filed are represented by two networks separately. The penalty terms containing the control equation is introduced into the loss function, and consequently the error estimate for the reconstructed solution are derived. This is a joint work with Dr. Qianxiao Li and Dr. Mengmeng Zhang.

Acknowledgement: This work is supported by NSFC 11971104 and NRF-NRFF13-2021-0005.

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Talk title: Solving inverse problems for nonlinear equations of the reaction-diffusion-advection type with data on the position of a reaction front

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Abstract:

Problems for nonlinear singularly perturbed reaction-diffusion-advection equations arise in gas dynamics, combustion theory, chemical kinetics, biophysics, medicine, ecology, finance and other fields of science. A specific feature of problems of this type is the presence of processes of different scales. Therefore, the mathematical models of these problems are described by nonlinear parabolic equations with a small parameter at the highest derivative. In this regard, solutions to these problems may contain narrow moving fronts that divide the space into two parts: the disturbed part, through which the front has already passed, and the undisturbed part. The front is a region in which the function describing some characteristic of the medium (temperature, density, etc.) changes quite sharply from the values of the function describing one state of the medium (for example, undisturbed) to the value of the function describing another state. If there is a small parameter with the highest derivative, the width of such a front will be rather small in relation to the size of the entire region. As a consequence, the reaction front can be sometimes distinguished experimentally.

Some applied problems for equations of this type require solving inverse problems for recovering some coefficient in the equation. To formulate the inverse problem, additional information is required, which is usually measured in an experiment. Often, in the formulation of inverse problems for partial differential equations, additional information about the solution on a

part of the boundary of the domain is used. However, one of the possible statements of inverse problems for equations of the type under consideration is a statement with additional information about the dynamics of the reaction front motion (see, for example, [1, 2, 3, 4]). Additional data of this type are in demand in practice, since they are most easily to observe in an experiments (the front is an easily distinguishable contrast structure).

The simplest formulation of an inverse problem of this type relates to the case of recovering a function of an argument from experimental observations of a function of the same argument. For example, in [2], an approach was considered to restore the function of a temporary variable argument from the observation data of the function also of the variable argument in time. More complex formulations are formulations in which it is required to restore the function of one argument (for example, spatial) from the observation data of the function of another argument (for example, temporal) [1, 3, 4]. This class of inverse problems is considered recently -- the recovering of the function of the argument of a spatial variable (that determines the properties of the medium) from the data of observations of the function of the argument of the time variable (that determined by the dynamics of the reaction front).

To effectively solve such inverse problems the methods of asymptotic analysis can be used (sometimes!). In such cases, it is possible to reduce the original inverse problem for a nonlinear singularly perturbed partial differential equation to a much simpler problem with respect to the coefficient to be restored. The resulting simplified problem is called as a reduced statement (formulation) of the inverse problem. However, the reduced formulations of such inverse problems may have special features. It was shown that the reduced formulations can contain 1) algebraic equations for an unknown coefficient (see, for example, [2], 2) differential equations for an unknown coefficient (see, for example, [4]), 3) integral equations for an unknown coefficient [1]. The first case is the simplest and allows to restore the unknown function only at those points through which the reaction front passed during its experimental observation. In this case, a point-wise recovering of the unknown coefficient is possible. The second case is more complicated, since additional input information is required for the correct formulation of the inverse problem being solved. The third case is the most difficult.

Often the methods of asymptotic analysis are inapplicable for solving inverse problems of this type (see, for example, [3]). In this case the methods based on minimizing the target functional by the gradient method are used to sole the inverse problem under consideration.

Thus, the features of numerical reconstruction of some coefficients in solving the coefficient inverse problem for a nonlinear singularly perturbed equation of the reaction-diffusion-advection type will be discussed.

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Talk title: Computable Characterization Methods for Objects with Convexity prior and Applications in Image Segmentation and Convex Hull Computation

Authors: Shousheng Luo, Xue-Cheng Tai, Yang Wang, Lingfeng Li, Roland Glowiski, Yunhai Xiao, Limei Huo and Jinfeng Chen

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Abstract:

In real images, objects are destroyed by occlusion, illumination bias and noise. Shape priors attract an increasing attention in real applications. Therefore, computable characterization method for convex objects is vital. We proposed two computable characterization methods (level set method and binary method) for convex shapes. Both of them utilize the fact that the convexity of any object is equivalent to the curvature nonnegativity of its boundary, which allows one to design efficient algorithms for involved applications. These two methods were generalized to handle multiple convex objects, convex ring and 3D convex objects (level set method). The characterization methods are applied to image segmentation and convex hull computation. ADMM algorithm and proximal ADMM algorithm were adopted to optimize the models using the two characterization methods, respectively.

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Talk title: Forward and inverse analyses for elastic and viscoelastic systems

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Abstract:

We consider anisotropic elastic systems and anisotropic viscoelastic systems. Compared with the isotropic case, the anisotropic case causes many difficulties to analyze these systems. They are mainly due to the lack of good algebraic and geometrical frameworks. As an example of difficulty, it is very hard to obtain a Carleman estimate which implies the unique continuation property (UCP) of solutions. The UCP is one of fundamental tools for studying inverse problems. Hence, we need to have that. Also, in many inverse problems, the coefficients of these system can have discontinuity and it can have a physically important meaning. Taking these into account, we have developed some forward and inverse analyses for these systems assuming that their coefficients are piecewise homogeneous or piecewise analytic. Under these frameworks, we will present some of our results for the forward and inverse problems for these systems.

Acknowledgement: This work is partially supported by Grant-in-Aid for Scientific Research of the

Japan Society for the Promotion of Science (19K03554 and 22K03366).

Talk title: Acoustic tomography and Gelfand-Levitan-Krein approach

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Abstract:

Early diagnosis of malignant tumors is one of the key problems in medicine. Currently, ultrasound tomographs are being developed by research groups many countries [1-7]. This work, which has been going on for more than 10 years, has reached the stage of pilot production. At the same time, there is still no industrially manufactured ultrasound tomograph.

One of the serious problems of ultrasound tomography is the development of the efficient numerical methods for solving inverse problems.

The most adequate model is a three-dimensional inverse problem in which the velocity of wave propagation, the density of the medium and acoustic attenuation have to be restored from the data of the pressure recorded by detectors located at the boundary of the region.

We also present the application of Gelfand-Levitan-Krein approach to acoustic tomography.

Acknowledgement: The work was supported by RSF, project 19-11-00154.

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Talk title: About methods of recovering of the magnetic fields using experimental data

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Abstract:

The development of the advanced technology extended our possibilities for acquisition of experimental data. For example, access to information about the magnetic fields of planets became possible due to the emergence and development of interplanetary missions. The data obtained thanks to these missions make it possible to solve inverse problems of reconstructing the distribution map of the magnetization parameters. The study of the magnetic fields of the planets is one of the ways to obtain information about the internal structure of the planet and its evolution. Also since in recent years the acquisition of the full tensor gradient data becomes available retrieval of magnetic parameters using magnetic tensor gradient measurements receives attention. In work [1], the problem of restoring magnetization parameters has been solved. In this problem three scalar functions (components of the magnetization vector) were recovered using data by five scalar functions (independent components of the magnetic tensor). In our work [2] we consider the problem of magnetic susceptibility restoration using magnetic tensor gradient measurements. In this work we have recovered one scalar function (magnetic susceptibility) using data by five scalar functions (components of the magnetic tensor). As we are dealing with the physically overdetermined problem we expect to receive better results than if the problem was just physically determined. In work [3], using approaches from works [1,2], the problem recovery of magnetization in the crust of Mars based on satellite data from the MAVEN mission (NASA's Mars MAVEN orbiter, 2020) has been solved. This task was physically determined since we have recovered three scalar functions

(components of the magnetization vector) by three scalar functions (independent components of the magnetic field). In the work [3] are also discussed possible ways to increase accuracy of restoration of magnetization parameters. Also we have recovered magnetization parameters in the crust of Mercury according to the data from the MESSENGER mission (2014). Using magnetization parameters in the crust of Mercury we solved forward problem and recalculated magnetic field on the spherical surface around Mercury and, applying Gauss-Mie expansion, we have received magnetization parameters of the magnetic masses in the crust of Mercury.

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Talk title: Identification problems of potential coefficients for time-fractional diffusion-wave equations

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Abstract:

In this talk, I will give some introductions to identification problems of potential coefficients for time-fractional diffusion-wave equations. Including the inverse time-dependent potential coefficient by using the boundary measured data at a point and by an additional integral condition as well as an inverse space-dependent potential coefficient by boundary measurement. The existence, uniqueness and regularity of the solution for the direct problems are provided. Based those, we try to give some uniqueness and conditional stability estimates for the inverse potential coefficient problems.

The Levenberg-Marquardt regularization method and two points gradient method are proposed to solve the inverse coefficient problems. Some numerical examples in one-dimensional case or in two-dimensional case are provided to show the effectiveness of the proposed methods.

Talk title: Inverse Problems for DCIS Model Based on Free Boundary Value Problems

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Abstract:

Mathematical modeling of tumor growth is an effective and important step in promoting knowledge about cancer, and has become one of the most attractive topics in mathematics and biology.

In this paper, we discuss two kinds of inverse problems based on deterministic and stochastic ductal carcinoma in situ (DCIS) models with free boundary conditions. First of all, based on the characteristics of deterministic DCIS model, we present an inverse problem of deterministic DCIS (IPdDCIS) under the conditions of incisional biopsy measurements at two different moments. The uniqueness solution to the IPdDCIS is proved. The IPdDCIS is transformed into a optimization problem, which is solved by particle swarm optimization method.

Since tumor concentration, boundary value functions and other parameters are inevitably affected by various random factors in the DCIS model, we mathematically formulate a kind of sDCIS model with free boundary conditions for the first time. In order to solve the sDCIS model, we construct effective numerical algorithms of an alternative iterative algorithm and random finite difference method. We establish theoretical results about the consistency and stability of the random finite difference scheme in mean square sense. The sampling finite difference scheme is presented by the Monte Carlo method to obtain statistical characteristics of numerical solutions, such as expectation and the standard deviation of numerical solutions. Based on the different types of measurement data, including incisional and needle biopsies, we propose three stochastic inverse problem for the sDCIS model. The numerical simulation results are included to demonstrate the validity of the method and accuracy of the mathematical formulation of the IPdDCIS and the IPsDCIS.

Coauthored with Professor Ge Meibao, School of Mathematics, Shanghai University of Finance and Economics, Shanghai 200433, P. R. CHINA.

Acknowledgement: This work was supported by the National Natural Science Foundation of China [Grant No. 11871435, 12071275, 11471287].

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Talk title: Inverse problem for a quasi-linear age structured population dynamics model

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Abstract:

In this talk, we discuss two kinds of inverse problems based on deterministic and stochastic ductal carcinoma in situ (DCIS) models with free boundary conditions. First of all, based on the characteristics of deterministic DCIS model, we present an inverse problem of deterministic DCIS (IPdDCIS) under the conditions of incisional biopsy measurements at two different moments. The uniqueness solution to the IPdDCIS is proved. The IPdDCIS is transformed into an optimization problem, which is solved by particle swarm optimization method. In a problem modeling the dynamics of an age-structured population, the conditions for the unambiguous recovery of two coefficients in a quasilinear partial differential transport equation of the first order are established. The equation models the maturation of individuals over time. The right-hand side of the equation is negative and defines the process of natural mortality of individuals, depending on age and on the density of individuals of a particular age. The recovery of the values of the model parameters is carried out in the framework of two inverse problems formulated under various additional conditions.

The resulting formulas are the basis for the numerical solution of the direct problem by the iterative method and for the numerical solution of the inverse problems, taking into account the ill-posedness of the inverse problems with approximate values of known functions.

Talk title: Boundary condition limitation in an inverse source problem and its overcoming

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Abstract:

In this report, I will point out the main disadvantage of the existing methods for solving an inverse source problem: The smoothness of the solutions is limited by the boundary condition. A Fourier extension method with a modified Tikhonov regularization is presented to overcome the limitation. Compared with previous studies, the convergence result of the new method is established under a weaker a priori assumption. Numerical experiments further verify the advantage of the method.

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Talk title: Direct Sampling Methods for Nonlinear Time-dependent Inverse Problems

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Abstract:

In this talk we shall first present some general ideas and motivations of the direct sampling type methods (DSMs) for solving nonlinear inverse problems of partial differential equations. Then we will discuss in detail how to construct a direct sampling method for solving time-dependent inverse problems, especially recovering the moving inhomogeneous inclusions, with the measurement data from a single initial data. The talk is mostly based on the theory and results in the work [1]. We will explain why the DSMs are computationally cheap, highly parallel, robust against noise, and applicable to the practical scenarios when very limited data is available. Numerical experiments will be demonstrated.

Acknowledgement: These research projects were supported by Hong Kong RGC General Research Fund (Projects 14306921 and 14306719).

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Invited Lectures (alphabetical order of surnames)

Talk title: An asymptotic expansion-regularization method for inverse source problems in singularly perturbed time-dependent partial differential equations

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Abstract:

In this talk, by employing the asymptotic expansion method, we prove the existence and uniqueness of a smoothing solution for a time-dependent nonlinear singularly perturbed partial differential equation (PDE) with a small-scale parameter. As a by-product, we obtain an approximate smooth solution, constructed from a sequence of reduced stationary PDEs with vanished high-order derivative terms. We prove that the accuracy of the constructed approximate solution can be in any order of this small-scale parameter in the whole domain, except a negligible transition layer. Furthermore, based on a simpler link equation be-tween this approximate solution and the source function, we propose an efficient algorithm, called the asymptotic expansion regularization (AER), for solving nonlinear inverse source problems governed by the original PDE. The convergence-rate results of AER are proven, and the a posteriori error estimation of AER is also studied under some a priori assumptions of source functions. Various numerical examples are provided to demonstrate the efficiency of our new approach

Talk title: Variational source conditions with applications to inverse problems in PDEs

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Abstract:

The concept of variational source condition was introduced nearly 15 years ago, and has led to many important progress on the theory of regularization. This talk is devoted to some previous and recent developments of the theory of variational source conditions, with emphasis on convergence rate analysis for inverse problems in PDEs. We will briefly outline the connections of variational source conditions with convergence rates, optimality and reverse results of regularization theory. Then, applications to Tikhonov regularization of some concrete inverse source and coefficients problems in Hilbert settings are present. In the end, we will propose and analyze variational source conditions for the Tikhonov regularization methods with L^p-penalties applied to an ill-posed inverse elliptic problems.

Talk title: Second-order flows for computing the ground states of rotating Bose-Einstein condensates

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Abstract:

We introduce two recently proposed second-order damped hyperbolic flows for approaching the ground states of rotating Bose-Einstein condensates (BECs). It was inspired by the recent advances of inertial dynamics with damping in convex optimization. The ground state of a rotating BEC can be mathematically modeled as a "minimizer" of the Gross-Pitaevskii energy functional with angular momentum rotational term under the normalization constraint. The proposed two types of second-order dissipative hyperbolic PDEs are served as energy minimization strategies for this constrained non-convex optimization problem. We shall focus on their numerical aspects in this talk. The talk is based on a joint work with Guozhi Dong, Wei Liu and Ziqing Xie.

Talk title: High resolution seismic faults interpretation based on adversarial neural networks with regularization technique

Authors: Tianqi Wang[1,2,3], Yanfei Wang[1,2,3]

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Abstract:

Geological fault detection at high precision and resolution is the key for fine structure and reservoir modeling (Di et al., 2017; Wang et al., 2018). Previous studies using neural networks for fault segmentation mainly focus on the local features of the targets (Huang et al., 2017; Zheng et al., 2014) and train the networks using synthetic datasets (Cunha et al., 2020; Wu et al., 2019). To increase the fault segmentation resolution only using a limited amount of seismic field data, we propose an adversarial neural network architecture for high-resolution identification of faults (FaultAdvNet) taking advantage of global feature fusion. The architecture consists of (1) a light-weight segmentation module (~0.49M parameters), (2) a feature fusion module considering reflectors of both faults and surrounding stratums, and (3) a discriminator module acting as a regularization term. Case studies using seismic field data from the Gulf of Mexico showed an

overwhelming performance improvement of the FaultAdvNet when compared with other fault detection methods. The FaultAdvNet picks all the faults with significantly high confidence and low prediction risk. The predicted faults of the FaultAdvNet are in good continuity and show clear boundary with fault probability values mainly range from ~0.95 to 1. Saliency analysis also suggests that the FaultAdvNet can focus on the target at a significantly higher resolution (dozens of meters). Functionality experiments verify the mechanisms of the feature fusion module and the discriminator module in FaultAdvNet. We consider that a neural network (like the discriminator) can serve as a data-driven regularization term to constrain the target network (the segmentation network) efficiently, especially given a limited amount of seismic data.

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Talk title: Estimating the memory parameter for possibly non-linear and non-Gaussian time series with wavelets

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Abstract:

The asymptotic theory for the memory parameter estimator constructed from log-regression with wavelets is incomplete for 1/f processes that are not necessarily Gaussian or linear. Such a theory is necessary due to the importance of non-Gaussian and nonlinear long memory models in describing financial time series. To fill this gap, we prove that under an assumption which can be implied by ergodicity and additional ones, the estimator is asymptotically consistent.

Talk title: Numerical solution of inverse problems for a time-fractional diffusion equation

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Abstract:

In this talk, we consider two inverse problems of identifying a pair of function $\{u(x,t),r(t)\}$ in the time fractional diffusion equation. By virtue of the high-precision Legendre spectral collocation and mollification method in the spatial and time direction severally, we present an efficient algorithm to solve the inverse problem. Finally, two numerical examples explicate the effectiveness and stability of the proposed method.

Talk title: A new framework to quantify the uncertainty in general inverse problems

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Abstract:

In this work, we investigate the regularized solutions and their finite element solutions to the inverse source problems governed by partial differential equations, and establish the stochastic convergence and optimal finite element convergence rates of these solutions, under point wise measurement data with random noise. The regularization error estimates and the finite element error estimates are derived with explicit dependence on the noise level, regularization parameter, mesh size, and time step size, which can guide practical choices among these key parameters in real applications. The error estimates also suggest an iterative algorithm for determining an optimal regularization parameter. Numerical experiments are presented to demonstrate the effectiveness of the analytical results.

Talk title: Uniqueness and numerical inversion in the time-domain fluorescence diffuse optical tomography

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Abstract:

This work considers the time-domain fluorescence diffuse optical tomography (FDOT). We recover the distribution of fluorophores in biological tissue by the boundary measurements. With the Laplace transform and the knowledge of complex analysis, we build the uniqueness theorem of this inverse problem. After that, the numerical inversions are considered. We introduce an iterative inversion algorithm under the framework of regularizing scheme, then give several numerical examples in three-dimensional space illustrating the performance of the proposed inversion schemes.

4. Introduction to Shenzhen MSU-BIT University

Brief

Built on the important consensus reached by Chinese President Xi Jinping and Russian President Vladimir Putin, Shenzhen MSU-BIT University (SMBU) is a non-profit Chinese-foreign cooperative university jointly founded by the Shenzhen Municipal People's Government, Lomonosov Moscow State University (MSU) and Beijing Institute of Technology (BIT) with an independent legal entity status.

Committed to building a world-class comprehensive and research-oriented university with distinctive strengths in its disciplines and global perspective, the University carries a glorious mission and a lofty mandate to nurture talents for the Belt & Road initiative, and dedicates herself into the development of elite education as well as high-level research and innovation activities. The University is determined to nurture high-caliber talents and achieve high quality academic excellence for China-Russia strategic cooperation and regional economic and social development.

SMBU's unique features

With the aim of training leading professionals in various fields, SMBU offers undergraduate, graduate, and PhD programs as well as non-diploma programs to current and prospective students. In the long run, SMBU expects to fulfill its capacity of 5000 students with the undergraduates-to-

graduates ratio reaching 1:1. SMBU started to enroll undergraduate and graduate students in 2017 and PhD students in 2018.

Chinese, Russian and English are the teaching languages at the University. SMBU adopts the "6:3:1 Evaluation Model" for the admission of Chinese undergraduate students, which is distinctive from basing the evaluation solely on the National College Entrance Exams. Upon admission into the University, freshmen will be registered as both the students of MSU and SMBU.

In accordance with the relevant regulations and agreements, qualified undergraduate students will be conferred the diplomas of MSU as well as the education certificates and diplomas of SMBU, while graduate and PhD students of SMBU will receive degrees from MSU.

Development Plan

With enormous trust and high expectations from the leaders and societies of the two countries, SMBU will strive for new achievements in the following 3 areas over the course of next 5 years amid challenges and opportunities.

1. Pick up development pace and elevate the quality of education in a comprehensive manner

Committed to becoming a world-class, international and comprehensive research university with distinctive characteristics, the University dedicates herself to the development of elite education as well as high-level research and innovation activities, so as to nurture high-caliber talent and achieving academic excellence for China-Russia strategic cooperation and regional economic and social development. Fulfilling the need of the national strategy, China-Russia cooperation as well as regional social and economic development, the University will, leveraging the academic strength of both MSU and BIT, develop programs that feature cutting-edge inter-disciplinary engineering technologies and disciplines in the area of fundamental science, forming a complete training system all the way from undergraduate to graduate and PhD programs.

2. Recruit globally and build up a world-class team of teachers

The University has started recruitment of global talent. Priority will be given to attracting teams led by globally esteemed scholars, leading professionals, and outstanding young teachers with an aim to build a world-class team of teachers.

3. Enhance scientific research capabilities and push forward the building of high-level scientific research platforms

SMBU will conduct scientific research in fields that are highly connected to development of the country and Guangdong-Hong Kong-Macao Greater Bay Area and speed up the process of laboratory building targeting world-leading basic research and cutting-edge technology development. The University has already established the Joint Research Center for Computational Mathematics and Cybernetics, the Russian-Sino Centre for Comparative Law, Research Center for

Cutting-edge Interdisciplinary Technologies, and SMBU-Sistema General Laboratory. The University is currently on track to establish Joint Research Center for Chemistry & Materials, Joint Research Center for Cutting-edge Science in Modern Biology and SMBU-Roscosmos General Laboratory in a bid to enhance capability in scientific research.

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