The 2nd Pacific Rim Mathematical Association Congress

Program and Abstracts

June 24 - 28, 2013

Shanghai • China

Hosted by:

Department of Mathematics, Shanghai Jiao Tong University

Organized by:

Pacific Rim Mathematical Association

PRIMA 2013

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Welcome

Dear Colleagues,

It is a pleasure for me to write a few words of welcome on behalf of the scientific and organizing committees for the 2013 PRIMA Congress, which will take place at Shanghai Jiao Tong University in the vibrant city of Shanghai, China on June 24- 28, 2013. PRIMA, the Pacific Rim Mathematical Association, was established in 2005 as an organization for promoting the development of mathematical sciences in the Pacific Rim region. Our most important activity is the PRIMA Congress, which is held every four years. Our inaugural event took place in Sydney, Australia in 2009.

The 2013 PRIMA Congress promises to be an exciting event, with world-class plenary lectures and public speakers. In addition there will be 23 special sessions or mini-symposia in a broad array of topics in the mathematical sciences, with participants from all over the Pacific Rim. Our host for this event is Shanghai Jiao Tong University, and they have done a wonderful job with the local arrangements. Aside from the excellent scientific program, the Congress will be a unique opportunity for participants to establish contacts throughout the Pacific Rim. We would like to invite the mathematical community to attend this meeting and join us in celebrating the incredible vitality and intellectual richness of our region.

We are looking forward to welcoming you to the 2013 PRIMA Congress in Shanghai!

With best regards,

Alejandro Adem
Director of PRIMA
University of British Columbia, Vancouver, Canada

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Organization

Scientific Committee

Alejandro Adem,
The University of British Columbia, Canada
Federico Ardila
San Francisco State University, USA
Marston Conder
University of Auckland, New Zealand
David Eisenbud
UC Berkeley, USA
Yakov Eliashberg
Stanford University, USA
Nassif Ghoussoub
The University of British Columbia, Canada
Tony Guttmann
University of Melbourne, Australia
Le Minh Ha
Vietnam National University, Vietnam
Shi Jin
Shanghai Jiao Tong University, China and University of Wisconsin-Madison, USA
Alejandro Jofré
University of Chile, Chile
Yujiro Kawamata
The University of Tokyo, Japan
Jong HaeKeum
Korea Institute for Advanced Study, Korea
Doug Lind
University of Washington, USA
KyewonKoh Park
Ajou University, Korea
Shige Peng
Shandong University, China
Jose Seade
Universidad Nacional Autónoma de México, México
Gang Tian
Princeton University and Peking University, USA/China
Tatiana Toro
University of Washington, USA

Local Organizing Committee at SJTU

Shi Jin (Chair)
David Cai
Dong Han
Jianguo Huang
Hongze Li
Yachun Li
Lihe Wang
Weike Wang
Ya-Guang Wang
Yaokun Wu
Dongmei Xiao
Pu Zhang
Xiao-Dong Zhang
Xiaoqun Zhang

Local Advisory Committee

Kungching Chang, Peking University
Weinan E, Princeton University and Peking University
Lei Guo, Chinese Academy of Sciences
Jiaxing Hong, Fudan University
Peiwen Ji, National Natural Science Foundation of China
Tatsien Li, Fudan University
Yiming Long, Nankai University
Zhongci Shi, Chinese Academy of Sciences
Jie Wang, National Natural Science Foundation of China
Jie Zhang, Shanghai Jiao Tong University

Public Lecturers

Ronald Graham, University of California, San Diego, USA
Cédric Villani, Université de Lyon and Institut Henri Poincaré, France

Plenary Lecturers

Martin Barlow, University of British Columbia, Canada
Andrea Bertozzi, University of California, Los Angeles, USA
Weinan E, Princeton University, USA and Peking University, China
Jun-Muk Hwang, Korea Institute for Advanced Study, Korea
Vaughan Jones, University of California, Berkeley, USA
Zhi-Ming Ma, Chinese Academy of Sciences, China
Matilde Marcolli, California Institute of Technology, USA
Arun Ram, University of Melbourne, Australia
Yongbin Ruan, University of Michigan, USA
Shuji Saito, Tokyo Institute of Technology, Japan
Weiping Zhang, Nankai University, China

Special Sessions & Organizers

1. A Glimpse of Stochastic Dynamics
Jinqiao Duan (University of California, Los Angeles & Illinois Institute of Technology, USA)
Hongjun Gao (Nanjing Normal University, China)
2. Algebraic and Complex Geometry
Yujiro Kawamata (The University of Tokyo, Japan)
JongHaeKeum (Korea Institute for Advanced Study, Korea)
3. Algebraic Topology and Related Topics
Alejandro Adem (The University of British Columbia, Canada)
Alan Jonathan Berrick (National University of Singapore, Singapore)
Craig Westerland (University of Melbourne, Australia)
4. Applications of Harmonic Maps and Submanifold Theory
Yuxin Dong (Fudan University, China)
Martin A. Guest (Waseda University, Japan)
Wei Zhang (University of Science and Technology of China, China)
5. Combinatorics and Discrete Mathematics
Andreas Dress (Chinese Academy of Sciences, China)
Jing Huang (University of Victoria, Canada)
Yaokun Wu (Shanghai Jiao Tong University, China)
6. Geometric Analysis
Jie Qing (University of California, Santa Cruz, USA)
Gang Tian (Princeton University and Peking University, USA/China)
Xiaohua Zhu (Peking University, China)
7. Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives
Nassif Ghoussoub (The University of British Columbia, Canada)
Manuel del Pino (University of Chile, Chile)
Juncheng Wei (The Chinese University of Hong Kong, Hong Kong)
8. Hyperbolic Conservation Laws and Related Applications
Feimin Huang (Chinese Academy of Sciences, China)
Dehua Wang (University of Pittsburgh, USA)
Ya-Guang Wang (Shanghai Jiao Tong University, China)
9. Inverse Problems
Guillaume Bal (Columbia University, USA)
Jin Cheng (Fudan University, China)
Gunther Uhlmann (University of Washington, USA)
10. Kinetic Equations
Radjesvarane Alexandre (Shanghai Jiao Tong University, China)
Benoit Perthame (University of Pierre and Marie Curie, France)
11. Mathematical Fluid Dynamics and Related Topics
Dongho Chae (Chung-Ang University, Korea)

Yoshikazu Giga (The University of Tokyo, Japan)
Yasunori Maekawa (Kobe University, Japan)
Tai-Peng Tsai (The University of British Columbia, Canada)

12. Mathematics of String Theory
Peter Bouwknegt (Australian National University, Australia)
Mathai Varghese (The University of Adelaide, Australia)
Siye Wu (Hong Kong University, Hong Kong)

13. Measurable and Topological Dynamics
Alejandro Maass (University of Chile, Chile)
Hitoshi Nakada (Keio University, Japan)
KyewonKoh Park (Ajou University, Korea)
Xiangdong Ye (University of Science and Technology of China, China)

14. Multiscale Analysis and Algorithms
Weinan E (Princeton University and Peking University, USA/China)
Carlos Garcia-Cervera (University of California, Santa Barbara, USA)
Pingbing Ming (Chinese Academy of Sciences, China)

15. Number Theory and Representation Theory
Clifton Cunningham (University of Calgary, Canada)
Atsushi Ichino (Kyoto University, Japan)
Vinayak Vatsal (The University of British Columbia, Canada)

16. Operator Algebras and Harmonic Analysis
Anthony Lau (University of Alberta, Canada)
Zhong-Jin Ruan (University of Illinois at Urbana-Champaign, USA)

17. Optimization
Regina Burachik (University of South Australia, Australia)
Xiaojun Chen (Hong Kong Polytechnic University, Hong Kong)
Alejandro Jofré (Center for Mathematical Modeling, Chile)
Hector Ramirez (Center for Mathematical Modeling, Chile)

18. Probability
Shige Peng (Shandong University, China)
Martin Barlow (The University of British Columbia, Canada)

19. Representation Theory and Categorification
Xuhua He (Hong Kong University of Science and Technology, Hong Kong)
Joel Kamnitzer (University of Toronto, Canada)
Tony Licata (Australian National University, Australia)
James Parkinson (University of Sydney, Australia)
Arun Ram (University of Melbourne, Australia)

20. Singularities in Geometry and Topology
Guangfeng Jiang (Peking University of Chemical Technology, China)
Laurentiu Maxim (University of Wisconsin-Madison, USA)
Mutsuo Oka (Tokyo University of Science, Japan)
Jose Seade (Universidad NacionalAutonoma de Mexico, Mexico)

21. Symplectic Geometry and Hamiltonian Dynamics
YakovEliashberg (Stanford University, USA)
Yiming Long (Nankai University, China)

22. Symplectic Geometry and Mathematical Physics
Xiaobo Liu (University of Notre Dame and Peking University, USA/China)
Huijun Fan (Peking University, China)

23. Triangulated Categories in Representation Theory of Algebras
Ragnar-Olaf Buchweitz (University of Toronto, Canada)
Shiping Liu (University of Sherbrook, Canada)
Claus Michael Ringel (Universitaet Bielefeld, Germany)
Pu Zhang (Shanghai Jiao Tong University, China)

Funding Agencies and Sponsors

PRIMA and the organizing committee of the 2nd PRIMA Congress wish to extend their thanks and appreciation to the following agencies for their supports to this congress.

Useful Information

Congress Venues

Opening Ceremony /Public & Plenary Lectures, Wen Zhi Hall, SJTU Xuhui Campus
Special Sessions & Contributed Talks, Engineering Hall, SJTU Xuhui Campus
Address: No. 1954, Hua Shan Road, Xuhui District, Shanghai, China
(上海交通大学徐汇校区地址：上海市徐汇区华山路 1954 号)

The Second PRIMA Congress will be convened at the Xuhui Campus of Shanghai Jiao Tong University. SJTU, one of the top universities of China, boasts a long history of more than 117 years. Xuhui Campus is located in Xujiahui, a shopping paradise and gourmet destination. There are many large department stores within walking distance, such as Grand Gateway, Oriental Department Store, Pacific Plaza, Metro City and Huijin Department Store, etc. There are also some ancient buildings nearby, and many great cafes and restaurants are located in the neighborhood.
Shanghai, as the largest city in China, has many tourist attractions, such as the Bund, Oriental Pearl Tower, Yu Garden, Chenghuang Temple and Longhua Temple etc.

Hotel

HUA TING HOTEL & TOWERS (华亭宾馆)
1200 North Cao Xi Road, Shanghai, China （上海市徐汇区漕溪北路1200号）
Telephone: +8621 64391000
Fax: +8621 6481 2070
Hotel website: http://www.huating.jinjianghotels.com

Transportation Directions

- **From Shanghai Pudong Airport (PVG) to the Xuhui Campus of SJTU**

  Metro: Take Metro Line 2 to East Nanjing Road Station, then transfer to Metro Line 10 to Shanghai Jiao Tong University Station; after that, walk for around 10 minutes then you can arrive at the Xuhui Campus. The whole journey is around 47km and may take you about 1 hour.

  Taxi: The whole journey is around 47km, which will take you around 35 minutes with 150 Yuan.
  If you want to go directly from Pudong Airport to the Congress Venue, please give the following message to the taxi driver:
  ---请载我到徐汇区华山路 1954 号上海交通大学(近广元西路)。
  ---Please take me to No. 1954, Hua Shan Road, Xuhui District, SJTU Xuhui Campus.

- **From Shanghai Hongqiao Airport (SHA) to SJTU Xuhui Campus**

  Metro: Take Metro Line 10 to Shanghai Jiao Tong University Station; after that, walk for around 10 minutes then you can arrive at the Xuhui Campus. The whole journey is around 10 km and may take you about 40 minutes.

Taxi: The whole journey is around 12 km, which will take you around 30 minutes with 50 Yuan.

If you want to go directly from Hongqiao Airport to the Congress Venue, please give the following message to the taxi driver:

---请载我到徐汇区华山路 1954 号上海交通大学。

---Please take me to No. 1954, Hua Shan Road, Xuhui District, SJTU Xuhui Campus.

◆ **From Shanghai Railway Station to the Xuhui Campus of SJTU**

Metro: Take Metro Line 1 to Xujiahui Station; after that, walk north along Huashan Road for around 10 minutes then you can arrive at the Xuhui Campus. The whole journey is around 10 km and may take you about 30 minutes.

Taxi: The whole journey is around 10 km, which will take you around 30 minutes with 50 Yuan.

◆ **From Hongqiao Railway Station to the Xuhui Campus of SJTU**

Metro: Take Metro Line 10 to Shanghai Jiao Tong University Station; after that, walk for around 10 minutes then you can arrive at Xuhui Campus. The whole journey is around 10 km and may take you about 40 minutes.

Taxi: The whole journey is around 12 km, which will take you around 30 minutes with 50 Yuan.

◆ **From Pudong International Airport (PVG) to Hua Ting Hotel & Towers**

Metro: 1. Take Metro Line 2 to People Square Station and change to Metro Line 1 and get off at Shanghai Indoor Stadium and get out from Exit 7. 2. Take the Metro Line 2 and change to Metro Line 4 at the Century Avenue Station, and take Metro Line 4 heading for Xinzhuang and get off at Shanghai Indoor Stadium Station and get out from Exit 7.

Bus: Take Airport Bus No. 7 and arrive at South Shanghai Railway Station and change to Metro Line 1 and get off at Shanghai Indoor Stadium Station, and get out from Exit 7.

Taxi: Take taxi for about 50 minutes. Normal taxi charge is about RMB ¥ 175, plus 30% night extra charge after 11:00 PM.

If you want to go directly from Pudong Airport to the Hotel, please give the following message to the taxi driver:

---请载我到徐汇区徐汇区漕溪北路1200号华亭宾馆。

宾馆前台电话：6439 1000

--- Please take me to 1200 North Cao Xi Road, Hua Ting Hotel & Towers.

Reception phone: 6439 1000

◆ **From Hongqiao Airport (SHA) to Hua Ting Hotel & Towers**

Metro: Take Metro Line 2 to People Square Station and change to Metro Line 1 and get off at Shanghai Indoor Stadium Station and get out from Exit 7.

Bus: Take Airport Bus No. 938. Get in the bus at Hongqiao Airport Station and get off at the cross of Western Zhongshan Road and North Caoxi Road.

Taxi: Normal taxi charge is about 60 RMB, plus 30% night extra charge if after 11:00 PM.
If you want to go directly from Hongqiao Airport to the Hotel, please give the following message to the taxi driver:
---请载我到徐汇区徐汇区漕溪北路1200号华亭宾馆。
宾馆前台电话：6439 1000
---Please take me to 1200 North Cao Xi Road, Hua Ting Hotel & Towers. Reception phone: 6439 1000

Way-finding & Shuttle Bus at Airports

The 2nd PRIMA local organizing committee has arranged shuttle bus to bring the attendees to the Hua Ting Hotel & Towers on **June 23**. The shuttle bus will be available during 9:00-21:00 in Pudong Airport (PVG), and it will leave PVG for Hua Ting Hotel & Towers every three hours (see the below form for more details); the shuttle bus will be available during 12:00-20:00 in Hongqiao Airport (SHA) and it will leave SHA for Hua Ting Hotel & Towers every two hours (see the below form for more details). The attendees may choose to take public transportations or take the shuttle bus based on their own arrival time and needs. Volunteers will be in both PVG and SHA to guide the attendees to the shuttle bus or help the attendees to find the taxi or the metro station. The volunteers will wear orange T-shirts with PRIMA and SJTU logos.

Shuttle Bus at Airports (June 23, Sunday)					
Airport	1st	2nd	3rd	4th	5th
PVG	9:00	12:00	15:00	18:00	21:00
SHA	12:00	14:00	16:00	18:00	20:00

Congress Bus

There will be buses to pick up the attendees at Hua Ting Hotel & Towers and send them to the congress venue (the Xuhui Campus of SJTU) every morning from June 24 to June 28.

Since there will be the congress banquet on Monday (June 24) evening so that congress buses will bring the attendees back from SJTU Xuhui Campus to the Hua Ting Hotel & Towers. However, in the later days (June 25-June 28) there will be no buses to bring the attendees back to the hotel after the meeting and they need to go back to the hotel by themselves.

Congress Bus Schedule			
Date	**Departure Time**	**From**	**To**
2013.06.24	8:00-8:30	Hua Ting Hotel & Towers	SJTU Xuhui Campus
	17:45	SJTU Xuhui Campus	Banquet
2013.06.25	7:30-8:00	Hua Ting Hotel & Towers	SJTU Xuhui Campus
2013.06.26	7:30-8:00	Hua Ting Hotel & Towers	SJTU Xuhui Campus
2013.06.27	7:30-8:00	Hua Ting Hotel & Towers	SJTU Xuhui Campus
2013.06.28	7:30-8:00	Hua Ting Hotel & Towers	SJTU Xuhui Campus

Dining

Lunch on Campus

1/F, 2/F, University Canteen (Xuhui Campus). The attendees can buy Lunch Tickets from the registration desk.

Off-campus Dining

Outside the campus is the center of the Xuhui District, which is a certified food paradise. The street outside of the gate at Panyu Road is lined with small eateries offering traditional Shanghainese food and Yunnan rice noodle. Be ready to pay at least 25 yuan for a decent meal. Further down the road is a Sihaiyoulong (四海游龙), a Taiwanese Fried Dumpling chain restaurant, where meals cost 30 yuan or so. By the gate at West Guang Yuan Road are various chain restaurants such as Yonghe King, Sukiya, etc.. Be ready to shell out 15 to 25 yuan per meal.
The Hunan and Northeastern restaurants on Panyu Road are good choices for get-togethers with friends and for a taste of Chinese food. Average expenditure per person is 40 to 60 yuan (excluding alcoholic drinks). You can also consider Ajisen Ramen on Huashan Road (40 yuan per person), sushi-go-round restaurant Sushi Express in MetroCity (6 yuan per plate), and Pizza Hut in MetroCity. If you are feeling a little ritzy, try Charme and South Memory. Your taste buds are sure to be satisfied, but be prepared to get out that hundred-yuan bill!

Standard Audio/Visual Set-up in Meeting Rooms

All meeting rooms for PRIMA 2013 will be equipped with one computer, one blackboard, and one overhead projector.
Speakers should load their talks to the computer before their speaking sessions.

Internet Access

Wireless internet access is available in all meeting rooms.
The user names are: math1; math2; math3; math4; math5; math6; math7; math8; math9;

math10
The password is: PLMN3148
Attendees staying at the hotel will be able to use the cable line to access to the internet or be provided with a password upon check-in for using the wireless connection.

Registration Fee Includes

- Printed scientific program
- Welcome reception
- Coffee breaks daily

Get-togethers

- Welcome reception at the Hua Ting Hotel & Towers
  Sunday, June 23
  18:00-19:30
- Banquet (self-paid) at the Hua Ting Hotel & Towers
  Monday, June 24
  18:00-20:00

Book Display

Six publishing houses will be present in the Second PRIMA Congress, and they are: Oxford University Press, Science Press, Springer, Advances in Mathematics (China), Acta Mathematica Sinica, and Higher Education Press. A large variety of books in mathematical science will be on display.

Medical Service

The University Campus Hospital will provide medical service to the congress attendees during June 24-28.
Special Medical Service Room for PRIMA: Room 105, Campus Hospital, 8:30-17:30, June 24-28
Emergency Call: 13788942692 (Mr. Liu)
If the attendees need medical assistance in any other time or need emergency service, directly dial the national ambulance number: 120

Please Note

PRIMA 2013 is not responsible for the safety and security of attendees' computers. Do not leave your laptop computers unattended. Please remember to turn off your cell phones during all talks.

Recording of Presentations

Audio and video recording of presentations at PRIMA 2013 meetings is prohibited without the written permission of the presenter and PRIMA.

Useful Links

- Shanghai Jiao Tong University
  http://en.sjtu.edu.cn/
- Department of Mathematics, SJTU
  http://www.math.sjtu.edu.cn/
- PRIMA 2013 Website
  http://meeting.healife.com/prima2013
- Institute of Natural Sciences, SJTU
  http://ins.sjtu.edu.cn/
- Pacific Rim Mathematical Association
  http://www.math.sjtu.edu.cn/Conference/prima/index.htm
- Shanghai Today
  http://www.shanghai-today.com/
- Shanghai Airline
  http://en.ceair.com/

Schedule-at-a-Glance

Schedule-at-a-Glance

On-site Registration: **Sunday, June 23 13:00-21:00, Hua Ting Hotel & Towers (1/F)**
Monday-Friday (June 24-28), 8:00-16:30, Room 114, Engineering Hall, SJTU Xuhui Campus

Congress Venues: **Opening Ceremony /Public & Plenary Lectures, Wen Zhi Hall, SJTU Xuhui Campus**
Special Sessions & Contributed Talks, Engineering Hall, SJTU Xuhui Campus

<table>
<tr><th>Time</th><th>Sunday
June 23</th><th>Monday
June 24</th><th>Tuesday
June 25</th><th>Wednesday
June 26</th><th>Thursday
June 27</th><th>Friday
June 28</th></tr>
<tr><td>8:30</td><td rowspan="7"></td><td></td><td rowspan="2">Plenary Lecture
Yongbin Ruan</td><td rowspan="2">Public Lecture
Ronald Graham</td><td rowspan="2">Plenary Lecture
Martin Barlow</td><td rowspan="2">Plenary Lecture
Vaughan Jones</td></tr>
<tr><td>9:00-
9:30</td><td>Opening
Ceremony</td></tr>
<tr><td>9:30-
10:20</td><td>Public Lecture
Cédric Villani</td><td>Plenary Lecture
Shuji Saito</td><td>Plenary Lecture
Weinan E</td><td>Plenary Lecture
Arun Ram</td><td>Plenary Lecture
Matlide Marcolli</td></tr>
<tr><td>10:30-
11:00</td><td colspan="5">Coffee Break</td></tr>
<tr><td>11:00-
11:50</td><td>Plenary Lecture
Zhi-Ming Ma</td><td>Plenary Lecture
Andrea Bertozzi</td><td>Plenary Lecture
Weiping Zhang</td><td>Plenary Lecture
Jun-Muk Hwang</td><td>Special Sessions &
Contributed Talks</td></tr>
<tr><td>12:00-
14:00</td><td colspan="5">Lunch</td></tr>
<tr><td>14:00-
16:00</td><td rowspan="3">Registration</td><td colspan="2">Special Sessions & Contributed Talks</td><td rowspan="3">Free Afternoon</td><td colspan="2">Special Sessions & Contributed Talks</td></tr>
<tr><td>16:00-
16:30</td><td colspan="2">Coffee Break</td><td>Coffee Break</td><td rowspan="3"></td></tr>
<tr><td>16:30-
17:30</td><td colspan="2">Special Sessions & Contributed Talks</td><td>Special Sessions
& Contributed
Talks</td></tr>
<tr><td>18:00-
19:30</td><td>Welcome
Reception</td><td>Banquet</td><td></td><td></td><td></td></tr>
</table>

Welcome Reception: Sunday, June 23, 18:00-19:30, Hua Ting Hotel & Towers
Banquet: Monday, June 24, 18:00-20:00, Hua Ting Hotel & Towers
Lunch: University Canteen/Faculty Club

Monday, June 24

Morning Lectures: at Wen Zhi Hall

9:00-9:30
Opening Ceremony

9:30-10:20
***Public Lecture*, Cédric Villani,** Université de Lyon and Institut Henri Poincaré, France
Of Triangles, Gas, Prices and Men
Chair: Jie Zhang, Shanghai Jiao Tong University, China

10:30-11:00
Coffee Break

11:00-11:50
***Plenary Lecture*, Zhi-Ming Ma,** Academy of Mathematics and Systems Science, CAS, China
Web Markov Skeleton Processes and Their Applications
Chair: Alejandro Adem**,** University of British Columbia, Canada

12:00-14:00
Lunch
Venue: University Canteen

Afternoon sessions: at Engineering Hall

14:00-16:00

Session 1: A Glimpse of Stochastic Dynamics (Room: 208)
Organizers: Jinqiao Duan, Hongjun Gao
14:00-14:30
Samuel Kou, Harvard University, USA
Fast Analysis of Dynamic Systems via Gaussian Emulator
14:30-15:00
Xu Sun, Huazhong University of Science and Technology, China
Fokker-Planck Equations for Nonlinear Dynamical Systems Driven by Non-Gaussian Lévy Processes
15:00-15:30
Huijie Qiao, Southeast University, China
Some Results for Discontinuous Random Dynamical Systems
15:30-16:00
Jinqiao Duan, Institute for Pure and Applied Mathematics, USA
Perspectives in Stochastic Dynamics—Modeling, Analysis and Computation

Session 2: Algebraic and Complex Geometry (Room: 207)
Organizers: Yujiro Kawamata, JongHae Keum
14:00-14:50
Jun Li, Stanford University, USA
Categorification of Donaldson-Thomas Invariants and Gopakumar-Vafa Invariants
15:00-15:50
Colin Ingalls, University of New Brunswick, Canada
Division Algebras of Transcendence Degree Two

Session 3: Algebraic Topology and Related Topics (Room: 229)
Organizers: Alejandro Adem, Alan Jonathan Berrick, Craig Westerland
14:00-14:30
Vigleik Angeltveit, Australian National University, Australia
The Topological Hochschild Homology of Thom Spectra as Cyclotomic Spectra
14:30-15:00
Ryan Budney, University of Victoria, Canada
Universal Constructions on Spaces of Knots

15:00-15:30

Haibao Duan, Institute of Mathematics, Chinese Academy of Sciences, China

Circle Actions on 5-Manifolds

Session 4: Applications of Harmonic Maps and Submanifold Theory (Room: 224)

Organizers: Yuxin Dong, Martin A. Guest, Wei Zhang

14:00-14:40

Reiko Miyaoka, Tohoku University, Japan

TBA

14:45-15:25

Peng Wang, Tongji University, China

Willmore Surfaces by Using Geometric Methods and Loop Group Theory

15:30-16:10

Erxiao Wang, Hong Kong University of Science and Technology, China

Definite Affine Spheres by the DPW Method

Session 5: Combinatorics and Discrete Mathematics (Room: 202)

Organizers: Andreas Dress, Jing Huang, Yaokun Wu

14:00-14:30

Pavol Hell , Simon Fraser University, Canada

Matrix Partitions

14:30-15:00

Jan Kratochvil, Charles University in Prague, Czech Republic

Geometric Representations of Graphs

15:00-15:30

Moshe Rosenfeld, University of Washington, Tacoma, USA

Hamiltonian Cycles in Prisms

15:30-16:00

Jack Koolen, University of Science and Technology of China, China and Pohang University of Science and Technology, Korea

On m-Walk-regular Graphs, a Generalization of Distance-regular Graphs

Session 6: Geometric Analysis (Room: 226)

Organizers: Jie Qing, Gang Tian, Xiaohua Zhu

14:00-14:30

Albert Chau, The University of British Columbia, Canada

TBA

14:30-15:00

Yalong Shi, Nanjing University, China

Bergman Kernel of a Polarized Kähler ALE Manifold

15:00-15:30

Yuji Odaka, Kyoto University, Japan

K-stability of Fano Varieties and Alpha Invariant

15:30-16:00

Xi Zhang, University of Science and Technology of China, China

The Limit of the Yang-Mills-Higgs Flow on Semi-stable Higgs Bundles

Session 7: Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives (Room: 218)

Organizers: Nassif Ghoussoub, Manuel delPino, Juncheng Wei

14:00-14:30

Fang-Hua Lin, Courant Institute, NYU, USA

TBA

14:30-15:00

Zhi-Qiang Wang, Nankai University, China and Utah State University, USA

Synchronized and Segregated Solutions for Coupled Nonlinear Schrödinger Equations

15:00-15:30

J.-M. Roquejoffre, University Toulouse, France

TBA

15:30-16:00

Daomin Cao, Chinese Academy of Sciences, China

Regularization of Point Vortex Solution for Euler Equation

Session 8: Hyperbolic Conservation Laws and Related Applications (Room: 100)

Organizers: Feimin Huang, Dehua Wang, Ya-Guang Wang

14:00-14:30

Alberto Bressan, Pennsylvania State University, USA

Some Counterexamples in the Theory of Conservation Laws

14:30-15:00

Shuxing Chen, Fudan University, China

Nonlinear Mixed Type Equations Arisen in Mach Reflection

15:00-15:30

John K. Hunter, University of California at Davis, USA

Normal Forms and a Burgers-Hilbert Equation

15:30-16:00

Eun Heui Kim, California State University Long Beach, USA

Global Solutions for Transonic Self-similar Two-dimensional Riemann Problems

Session 10: Kinetic Equations (Room: 220)

Organizers: Radjesvarane Alexandre, Benoit Perthame

14:00-14:30

Kazuo Aoki, Kyoto University, Japan

TBA

14:30-15:00

Nicolas Vauchelet, University of Pierre and Marie Curie, France

Kinetic Description of Bacterial Motion by Chemotaxis and Asymptotics

15:00-15:30

Xuguang Lu, Tsinghua University, China

Condensation and Regularity for Boson Boltzmann Equation

15:30-16:00

Peter Markowich, King Abdullah University of Science and Technology, Kingdom of Saudi Arabia

Hamiltonian Propagation of Mono-kinetic Measures with Rough Initial Profiles

Session 11: Mathematical Fluid Dynamics and Related Topics (Room: 228)

Organizers: Dongho Chae, Yoshikazu Giga, Yasunori Maekawa Tai-Peng Tsai

14:00-14:50

Chun Liu, Pennsylvania State University, USA

Some New Advances on Modeling and Algorithms Development of Multiphase Complex Fluid System Using the Phase Field Method

15:00-15:50

Maria Schonbek, University of California, Santa Cruz, USA

Asymptotic Stability of Mild Solutions to the Navier-Stokes Equations

Session 12: Mathematics of String Theory (Room: 234)

Organizers: Peter Bouwknegt, Mathai Varghese, Siye Wu

14:00-15:00

Ugo Bruzzo, International School for Advanced Studies (SISSA), Italy

Stacky Resolutions of the Moduli Spaces of Instantons on ALE Spaces

15:00-15:30

Jarah Evslin, Institute of High Energy Physics, CAS, China

Topology Change from Heterotic Narain T-Duality

15:30-16:00

Hisham Sati , University of Pittsburgh, USA

M-branes and Higher Bundles

Session 13: Measurable and Topological Dynamics (Room: 104)

Organizers: Alejandro Maass, Hitoshi Nakada, KyewonKoh Park, Xiangdong Ye

14:00-14:30

Anthony Dooley, University of Bath, UK

Random Dynamical Systems

14:30-15:00

Masato Tsujii, Kyushu University, Japan

The Semi-classical Zeta Function for Contact Anosov Flow

15:00-15:30
Uijin Jung, Ajou University, Korea
Decomposition Problems in Symbolic Dynamics
15:30-16:00
Song Shao, University of Science and Technology of China, China
Higher Order Bohr Problem and Related Topics

Session 15: Number Theory and Representation Theory (Room: 105)
Organizers: Clifton Cunningham, Atsushi Ichino, Vinayak Vatsal
14:00-14:30
Noriyuki Abe, Hokkaido University, Japan
On a Classification of Irreducible Modulo p Representations of p-adic Groups
14:30-15:00
Pramod N. Achar, Louisiana State University, USA
Parity Sheaves on the Affine Grassmannian and the Mirkovic-Vilonen Conjecture
15:00-15:30
Julia Gordon, University of British Columbia, Canada
Uniform in p Estimates for Orbital Integrals
15:30-16:00
Masoud Kamgarpour, University of Queensland, Australia
On the Center of Lie Algebras

Session 16: Operator Algebras and Harmonic Analysis (Room: 106)
Organizers: Anthony Lau, Zhong-Jin Ruan
14:00-14:30
Liming Ge, University of New Hampshire, USA
Uncertainty Principles for Infinite Abelian Groups
14:30-15:00
Narutaka Ozawa, Kyoto University, Japan
Quantum Correlations and Tsirelson's Problem
15:00-15:30
Chunlan Jiang, Hebei Normal University, China
Complex Geometry and Similarity of Cowen-Douglas Operators
15:30-16:00
Zhiguo Hu, University of Windsor, Canada
Convolution Algebras Associated with Locally Compact Quantum Groups

Session 17: Optimization (Room: 110)
Organizers: Regina Burachik, Xiaojun Chen, Alejandro Jofré, Hector Ramirez
14:00-14:40
Xiaojun Chen, The Hong Kong Polytechnic University, Hong Kong, China
Expected Residual Minimization for Stochastic Variational Inequalities
14:40-15:20
Gui-Hua Lin, Shanghai University, China
Solving Mathematical Programs with Equilibrium Constraints as Constrained Equations
15:20-16:00
Rafael Correa, Universidad de Chile, Chile
Existence of Minimizers on Drops

Session 18: Probability (Room: 103)
Organizers: Shige Peng, Martin Barlow
14:00-14:30
Xin Guo, University of California, Berkeley, USA
Martingale Problem under Non-linear Expectations
14:30-15:00
Rainer Buckdahn, Université de Bretagne Occidentale, France
TBA
15:00-15:30
Feng-Yu Wang, Beijing Normal University, China
Bismut Formula and Gradient Estimates for SDEs Driven by Multiplicative Levy Noise
15:30-16:00
Louis Chen, National University of Singapore, Singapore
Multivariate Normal Approximation by Stein's

Method: The Concentration Inequality Approach

Session 19: Representation Theory and Categorification (Room:107)

Organizers: Xuhua He, Joel Kamnitzer, Tony Licata, James Parkinson, Arun Ram

14:00-15:00

Anthony Henderson, University of Sydney, Australia

The Modular Generalized Springer Correspondence

15:00-15:30

Haibao Duan, Institute of Mathematics, Chinese Academy of Sciences, China

Schubert Calculus and Cohomology of Lie Groups

15:30-16:00

Hiroyuki Ochiai, Kyushu University, Japan

On Orbits in Double Flag Varieties for Symmetric Pairs

Session 21: Symplectic Geometry and Hamiltonian Dynamics (Room: 216)

Organizers: Yakov Eliashberg, Yiming Long

14:00-14:50

Yongbin Ruan, University of Michigan, Ann Arbor, USA

Witten Equation and the Geometry of LG-model

15:00-15:50

Sheila Sandon, Université de Nantes, France

Translated Points and Contact Rigidity

Session 23: Triangulated Categories in Representation Theory of Algebras (Room: 214)

Organizers: Ragnar-Olaf Buchweitz , Shiping Liu, Claus Michael Ringel, Pu Zhang

14:00-14:45

Idun Reiten, Norwegian University of Science and Technology, Norway

Triangulated Categories and Tau-tilting Theory

14:50 -15:20

Martin Herschend, Nagoya University, Japan

Geigle-Lenzing Spaces and Canonical Algebras in Dimension d (I)

15:25-15:55

Osamu Iyama, Nagoya University, Japan

Geigle-Lenzing Spaces and Canonical Algebras in Dimension d (II)

Contributed Talks Group 3: Discrete Mathematics (Room: 219)

Chair: Eiichi Bannai, Shanghai Jiao Tong University, China

14:00-14:20

Xiao-Dong Zhang, Shanghai Jiao Tong University, China

The Number of Subtrees of a Tree

14:20-14:40

Jiyou Li, Shanghai Jiao Tong University, China

The Subsets Counting Problems and Their Applications

14:40-15:00

Liangxia Wan, Beijing Jiaotong University, China

Unimodality of Genus Distribution of Ladders

15:00-15:20

Lemin Gu, Tongji University, China

Generalization of Legendre Polynomials Theory

15:20-15:40

Peng Li, Shanghai Jiao Tong University, China

Paths and Cycles of Interval Graphs

15:40-16:00

Ziqing Xiang, Shanghai Jiao Tong University, China

The Lit-only σ -Game

Contributed Talks Group 4: Computational Mathematics & Optimization (Room: 221)

Chair: Wenjun Ying, Shanghai Jiao Tong University, China

14:00-14:20

Jianguo Huang, Shanghai Jiao Tong University, China

An Uzawa Method for Solving Steady Navier-Stokes Equations Discretized by Mixed Element Methods

14:20-14:40

Qin Li, University of Wisconsin-Madison, USA

Semi-classical Limit for the Schroedinger Equation with Lattice Potential, and Band-crossing

14:40-15:00

AbdurRashid, Gomal University, Pakistan

Legendre Pseudospectral Method for Solving Three-dimensional Non-Linear Hyperbolic Partial Differential Equations

15:00-15:20

Xingzhong Shi, Wenzhou-Kean University, China

Math and Gaming

15:20-15:40

Congmin Wu, Xiamen University, China

MD Simulations for Motions of Evaporative Droplets Driven by Thermal Gradients

15:40-16:00

Hongyu Zhu, University of Texas at Austin, USA

Inversion of Geothermal Heat Flux in a Thermomechanically Coupled Stokes Ice Sheet Model

Contributed Talks Group 6: Probability and Statistics (Room: 222)

Chair: Dong Han, Shanghai Jiao Tong University, China

14:00-14:20

Jielin Zhu, University of British Columbia, Canada

Asymptotic Analysis for Tipping Points Problems

14:20-14:40

Yanyan He, Florida State University, USA

Data Fusion Based on Evidence Theory

14:40-15:00

Xiang Zhou, City University of Hong Kong, Hong Kong, China

Explicit Cross Entropy Scheme for Mixture

15:00-15:20

Xiaoming Fan, Southwest Jiao Tong University and Beijing Normal University, China

Estimates of Ito Integral and Applications to Random Dynamical Systems

15:20-15:40

Elena Karachanskaya, Pacific National University, Russia

The Generalized Ito-Wentzell Formula for Ito's Process and the Stochastic First Integral

16:00-16:30

Coffee Break

16:30-17:30

Session 1: A Glimpse of Stochastic Dynamics (Room: 208)

Organizers: Jinqiao Duan, Hongjun Gao

16:30-17:00

Dong Zhao, Academy of Mathematics & Systems Science, CAS, China

Malliavin Matrix of Degenerate PDE and Gradient Estimates

17:00-17:30

Wei Wang, Nanjing University, China

Self-similarity for Some SPDEs

Session 2: Algebraic and Complex Geometry (Room: 207)

Organizers: Yujiro Kawamata, JongHae Keum

16:30-17:20

Amnon Neeman, The Australian National University, Australia

Compacts

Session 3: Algebraic Topology and Related Topics (Room: 229)

Organizers: Alejandro Adem, Alan Jonathan Berrick, Craig Westerland

16:30-17:00

Soren Galatius, Stanford University, USA

Cohomology of Moduli Spaces of Manifolds

17:00-17:30

Daniel Juan Pineda, National Autonomous University of Mexico, Mexico

Braid Groups of Surfaces and Their Lower Algebraic K-theory

Session 4: Applications of Harmonic Maps and Submanifold Theory (Room: 224)

Organizers: Yuxin Dong, Martin A. Guest, Wei Zhang

16:40-17:20

Yoshihiro Ohnita, Osaka City University and OCAMI, Japan

Geometry of Lagrangian Submanifolds Related to Isoparametric Hypersurfaces

Session 5: Combinatorics and Discrete Mathematics (Room: 202)

Organizers: Andreas Dress, Jing Huang, Yaokun Wu

16:30-17:00

Bruce Reed, McGill University, Canada

The Structure of a Typical H-free Graph

17:00-17:30

Sang-il Oum, Korea Advanced Institute of Science and Technology, Korea

Unavoidable Vertex-minors in Large Prime Graphs

Session 6: Geometric Analysis (Room: 226)

Organizers: Jie Qing, Gang Tian, Xiaohua Zhu

16:30-17:00

Bing Wang, University of Wisconsin-Madison, USA

The Regularity of Limit Space

17:00-17:30

Jihun Park, Institute for Basic Science & Pohang University of Science and Technology, Korea

α-Functions of Smooth del Pezzo Surfaces

Session 7: Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives (Room: 218)

Organizers: Nassif Ghoussoub, Manuel del Pino, Juncheng Wei

16:30-17:00

Monica Musso, Universidad Católica de Chile, Chile

Critical Trudinger Moser Equation in R^2

17:00-17:30

Masaharu Taniguchi, Okayama University, Japan

Multi-dimensional Traveling Fronts in Bistable Reaction-diffusion Equations

Session 8: Hyperbolic Conservation Laws and Related Applications (Room: 100)

Organizers: Feimin Huang, Dehua Wang, Ya-Guang Wang

16:30-17:00

Zhouping Xin, The Chinese University of Hong Kong, Hong Kong, China

On the Existence of Meyer Type Transonic Flows and a Degenerate Change Type Equation

17:00-17:30

Mikhail Feldman, University of Wisconsin-Madison, USA

Shock Reflection and Von Neumann Conjectures

Session 10: Kinetic Equations (Room: 220)

Organizers: Radjesvarane Alexandre, Benoit Perthame

16:30-17:00

Benoit Perthame, University of Pierre and Marie Curie and Institut Universitaire de France, France

Scalar Conservation Laws and Kinetic Formulation

17:00-17:30

Lingbing He, Tsinghua University, China

On the Spatially Homogeneous Boltzmann and Landau Equations

Session 11: Mathematical Fluid Dynamics and Related Topics (Room: 228)

Organizers: Dongho Chae, Yoshikazu Giga, Yasunori Maekawa Tai-Peng Tsai

16:30-16:55

Tsuyoshi Yoneda, Hokkaido University, Japan

Topological Instability of Laminar Flows for the Two-dimensional Navier-Stokes Equation with Circular Arc No-slip Boundary Conditions

17:00-17:25

Dong Li, University of British Columbia, Canada
TBA

Session 12: Mathematics of String Theory (Room: 234)

Organizers: Peter Bouwknegt, Mathai Varghese, Siye Wu
16:30-17:00
Mathai Varghese, The University of Adelaide, Australia
T-Duality for Circle Bundles via Noncommutative Geometry
17:00-17:30
Matilde Marcolli, California Institute of Technology, USA
A Motivic Approach to Potts Models

Session 13: Measurable and Topological Dynamics (Room: 104)

Organizers: Alejandro Maass, Hitoshi Nakada, KyewonKoh Park, Xiangdong Ye
16:30-17:00
Hiroki Sumi , Osaka University, Japan
Negativity of Lyapunov Exponents in Generic Random Dynamical Systems of Complex Polynomials
17:00-17:30
Ercai Chen, Nanjing Normal University, China
TBA

Session 15: Number Theory and Representation Theory (Room: 105)

Organizers: Clifton Cunningham, Atsushi Ichino, Vinayak Vatsal
16:30-17:00
Syu Kato, Kyoto University, Japan
A homological study of Green polynomials
17:00-17:30
David Roe, University of Calgary, Canada
Geometrizing Characters of Tori

Session 16: Operator Algebras and Harmonic Analysis (Room: 106)

Organizers: Anthony Lau, Zhong-Jin Ruan
16:30-17:00
Volker Runde, University of Alberta, Canada
Ergodic Theory over Locally Compact Quantum Groups
17:00-17:30
Yong Zhang, University of Manitoba, Canada
Amenability Properties of Weighted Group Algebras

Session 17: Optimization (Room: 110)

Organizers: Regina Burachik, Xiaojun Chen, Alejandro Jofré, Hector Ramirez
16:30-17:00
Juan Peypouquet, Universidad Tecnica Federico Santa Marıa, Chile
A Dynamical Approach to an Inertial Forward-backward Algorithm for Convex Minimization
17:00-17:30
Felipe Alvarez, Universidad de Chile, Chile
Regularized Interior Proximal Alternating Directions Method

Session 18: Probability (Room: 103)

Organizers: Shige Peng, Martin Barlow
16:30-17:00
Yongsheng Song, Chinese Academy of Sciences, China
Backward Stochastic Differential Equations Driven by G-Brownian Motion
17:00-17:30
Jianfeng Zhang, University of Southern California, USA
Viscosity Solutions of Path Dependent PDEs

Session 19: Representation Theory and Categorification (Room: 107)

Organizers: Xuhua He, Joel Kamnitzer, Tony Licata, James Parkinson, Arun Ram
16:30-17:00
Hiraku Nakajima, Kyoto University, Japan
Cluster Algebras and Singular Supports of Perverse Sheaves

Session 21: Symplectic Geometry and Hamiltonian Dynamics (Room: 216)

Organizers: Yakov Eliashberg, Yiming Long

16:30-17:20

Mei-Lin Yau, National Central University, Taiwan

Isotopy of Lagrangian Tori Revisited

Contributed Talks Group 3: Discrete Mathematics (Room: 219)

Chair: Xiao-Dong Zhang, Shanghai Jiao Tong University, China

16:30-16:50

Aaron Dutle, University of South Carolina, USA

Realizations of Joint Degree Matrices

16:50-17:10

Trent G. Marbach, The University Of Queensland, Australia

The Spectrum of 3-Way k-Homogeneous Latin Trades

17:10-17:30

David Cariolaro, Xi'an Jiaotong-Liverpool University, China

Edge Colouring Graphs with Bounded Colour Classes

Contributed Talks Group 4: Computational Mathematics & Optimization (Room: 221)

Chair: Jinyan Fan, Shanghai Jiao Tong University, China

16:30-16:50

Julian Romero Barbosa, University of Los Andes, Colombia

A Semidefinite Approximation for Symmetric Travelling Salesman Polytopes

16:50-17:10

Lu Zong, Xi'an Jiaotong -Liverpool University, China

Modelling of Temperature and Pricing Weather Derivatives: a Comparison for Mainland China

17:10-17:30

Cheng Wang, University of Massachusetts Dartmouth, USA

Linear Numerical Schemes for Epitaxial Thin Film Growth Model with Energy Stability

18:00-20:00

Banquet

Venue: Hua Ting Hotel & Towers

Tuesday, June 25

Morning Lectures: at Wen Zhi Hall

8:30-9:20
***Plenary Lecture,* Yongbin Ruan,** University of Michigan, USA
Searching the Quantum Symmetry
Chair: Gang Tian, Princeton University, USA and Peking University, China

9:30-10:20
***Plenary Lecture*, Shuji Saito,** Tokyo Institute of Technology, Japan
Geometric Class Field Theory and Existence Conjecture of Smooth l-adic Sheaves on Varieties over Finite Fields
***Chair**:* Gang Tian, Princeton University, USA and Peking University, China

10:30-11:00
Coffee Break

11:00-11:50
***Plenary Lecture*, Andrea Bertozzi,** University of California, Los Angeles, USA
The Mathematics of Crime
Chair: Weinan E, Princeton University, USA and Peking University, China

12:00-14:00
Lunch

Afternoon sessions: at Engineering Hall

14:00-16:00

Session 1: A Glimpse of Stochastic Dynamics (Room: 208)
Organizers: Jinqiao Duan, Hongjun Gao
14:00-14:30
Shanjian Tang, Fudan University, China
Path-Dependent Optimal Stochastic Control and Viscosity Solution of Associated Bellman Equations
14:30-15:00
Guangyue Han , University of Hong Kong, Hong Kong, China
Refinements of the Shannon-McMillan-Breiman Theorem
15:00-15:30
Xiaoying Han, Auburn University, USA
Convergent Analysis of Methods for Non-linear Filtering Problems
15:30-16:00
Hongjun Gao, Nanjing Normal University, China
Large Deviations for the Stochastic Two-component b-Family System

Session 2: Algebraic and Complex Geometry (Room: 207)
Organizers: Yujiro Kawamata, JongHae Keum
14:00-14:50
Junkai Chen, National Taiwan University, Taiwan
Pluricanonical Maps and Minimal Models of Threefolds
15:00-15:50
De-Qi Zhang, National University of Singapore, Singapore
Positivity of Log Canonical Divisors and Mori/Brody Hyperbolicity

Session 3: Algebraic Topology and Related Topics (Room: 229)
Organizers: Alejandro Adem, Alan Jonathan Berrick, Craig Westerland
14:00-14:30
Fengchun Lei, Dalian University of Technology, China

TBA

14:30-15:00

Zhi Lü, Fudan University, China

Equivariant Chern Numbers and the Number of Fixed Points for Unitary Torus Manifolds

15:00-15:30

Ernesto Lupercio, Center for Research and Advanced Studies of the National Polytechnic Institute, Mexico

Virtual Orbifold Cohomology

15:30-16:00

Alejandro Adem, University of British Columbia, Canada

Homotopy Colimits and Commutative Elements in Lie Groups

Session 4: Applications of Harmonic Maps and Submanifold Theory (Room: 224)

Organizers: Yuxin Dong, Martin A. Guest, Wei Zhang

14:00-14:40

Ting-Hui Chang, Academia Sinica, Taiwan

The Liouville Property for Pseudoharmonic Maps with Finite Dirichlet Energy

14:45-15:25

Hezi Lin, Fujian Normal University, China

A Rigidity Theorem for Self-shrinkers of the Mean Curvature Flow

15:30-16:10

Chen-Yu Chi, National Taiwan University, Taiwan

On the Toda Systems of VHS Type

Session 5: Combinatorics and Discrete Mathematics (Room: 202)

Organizers: Andreas Dress, Jing Huang, Yaokun Wu

14:00-14:30

Jaroslav Nešetřil, Charles University, Czech Republic

Structural Limits in Logical and Analytic Context

14:30-15:00

L. Sunil Chandran, Indian Institute of Science, Bangalore, India

Boxicity and Cubicity of Graphs

15:00-15:30

Andreas Brandstädt, University of Rostock, Germany

On the Efficient Solution of Some Packing and Covering Problems in Graphs

15:30-16:00

Jayme Luiz Szwarcfiter, Federal University of Rio de Janeiro, Brazil

On the Computation of the Radon Number in Some Graph Convexities

Session 6: Geometric Analysis (Room: 226)

Organizers: Jie Qing, Gang Tian, Xiaohua Zhu

14:00-14:30

Xiaodong Cao, Cornell University, USA

Curvature Behavior at Singularity Time of Ricci Flow

14:30-15:00

Xiaoli Han, Tsinghua University, China

Symplectic Mean Curvature CP^2

15:00-15:30

Shucheng Chang, National Taiwan University, Taiwan

Complete Pseudohermitian Manifolds with Positive Spectrum

15:30-16:00

Haozhao Li, University of Science and Technology of China, China

Convergence of Calabi Flow with Small Initial Data

Session 7: Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives (Room: 218)

Organizers: Nassif Ghoussoub, Manuel delPino, Juncheng Wei

14:00-14:30

Changfeng Gui, University of Connecticut, USA

TBA

14:30-15:00

Mike Kowalczyk, Universidad de Chile, Chile
TBA
15:00-15:30
Juan Davila, Universidad de Chile, Chile
Nonlocal Minimal Surfaces
15:30-16:00
Shusen Yan, The University of New England, Australia
Bubbling Solutions for the Chern-Simons Model

Session 8: Hyperbolic Conservation Laws and Related Applications (Room: 100)
Organizers: Feimin Huang, Dehua Wang, Ya-Guang Wang
14:00-14:30
Song Jiang, Institute of Applied Physics and Computational Mathematics, China
Incompressible Limit of the Non-isentropic Ideal Magnetohydrodynamic Equations
14:30-15:00
Volker Elling, University of Michigan, Ann Arbor, USA
Self-similar Vortex Spiral Solutions of the 2d Incompressible Euler Equations
15:00-15:30
Yongqian Zhang, Fudan University, China
Weakly Nonlinear Geometric Optics for Hyperbolic Systems of Conservation Laws
15:30-16:00
Tong Li, University of Iowa, USA
Traveling Waves of Chemotaxis Models

Session 9: Inverse Problems (Room: 219)
Organizers: Guillaume Bal, Jin Cheng, Gunther Uhlmann
14:00-14:30
Gang Bao, Zhejiang University, China and Michigan State University, USA
Inverse Scattering Problems in Wave Propagation
14:30-15:00
Otmar Scherzer, University of Vienna, Austria
TBA
15:00-15:30
Michael Lamoureux, University of Calgary, Canada
Multi-scale Full Waveform Inversion for Seismic Imaging
15:30-16:00
Kui Ren, University of Texas at Austin, USA
Inverse Problems to Elliptic Systems in Quantitative (Fluorescence) Photoacoustic Tomography

Session 10: Kinetic Equations (Room: 220)
Organizers: Radjesvarane Alexandre, Benoit Perthame
14:00-14:30
Cédric Villani, Université de Lyon and Institut Henri Poincaré, France
TBA
14:30-15:00
Irene Gamba, University of Texas-Austin, USA
Angular Averaging, Propagation of Exponential Tails and Grazing Collisions for Solutions of the Boltzmann Equation
15:00-15:30
Shih-Hsien Yu, National University of Singapore, Singapore
Viscous Wave Propagation at Interface
15:30-16:00
Giuseppe Toscani, University of Pavia, Italy
TBA

Session 11: Mathematical Fluid Dynamics and Related Topics (Room: 228)
Organizers: Dongho Chae, Yoshikazu Giga, Yasunori Maekawa Tai-Peng Tsai
14:00-14:50
Zhouping Xin, The Chinese University of Hong Kong, Hong Kong, China
On Vanishing Viscosity Limit for 3-Dimensional Incompressible Navier-Stokes Equations with a Slip Boundary Condition
15:00-15:50
Seung-Yeal Ha, Seoul National University, Korea

Well-posedness of Coupled Kinetic-fluid Models for Flocking

Session 12: Mathematics of String Theory (Room:234)

Organizers: Peter Bouwknegt, Mathai Varghese, Siye Wu

14:00-14:30

Pedram Hekmati , University of Adelaide, Australia

T-duality Commutes with Reduction

14:30-15:00

Fei Han, National University of Singapore, Singapore

Equivariant Cohomology and Bismut-Chern Character in the Stolz-Teichner Program

15:00-15:30

David Ridout, The Australian National University, Australia

The Wess-Zumino-Witten Model on SL (2;R)

Session 13: Measurable and Topological Dynamics (Room: 104)

Organizers: Alejandro Maass, Hitoshi Nakada, KyewonKoh Park, Xiangdong Ye

14:00-14:30

Shigeki Akiyama, University of Tsukuba, Japan

Height Reducing Problem

14:30-15:00

Jeong-Yup Lee, Kwandong University, Korea

Overlap and Strong Coincidences on Substitution Tilings

15:00-15:30

Juan Rivera-Letelier, Pontificia Catholic University, Chile

TBA

15:30-16:00

Dou Dou, Nanjing University, China

Local Entropy Dimension for a Measure and a Variational Principle

Session 14: Multiscale Analysis and Algorithms (Room: 102)

Organizers: Weinan E, Carlos Garcia-Cervera, Pingbing Ming

14:00-14:30

Christof Schutte, Max Planck Institute for Molecular Genetics, Germany

TBA

14:30-15:00

Tiejun Li, Peking University， China

TBA

15:00-15:30

Di Liu, Michigan State University, USA

Multiscale Modeling and Computation of Nano Optical Responses

15:30-16:00

Zhijian Yang, Wuhan University, China

Generalized Irving-Kirkwood Formula for the Calculation of Continuum Quantities in Molecular Dynamics Models

Session 15: Number Theory and Representation Theory (Room: 105)

Organizers: Clifton Cunningham, Atsushi Ichino, Vinayak Vatsal

14:00-14:30

Jianshu Li, Hong Kong University of Science and Technology, Hong Kong, China

On the First Betti Number of Hyperbolic Arithmetic Manifolds

14:30-15:00

Wen-Wei Li, Chinese Academy of Sciences, China

On the Elliptic Part of the Trace Formula for Sp(2n)

15:00-15:30

Paul Mezo, Carleton University, Canada

Twisted Spectral Transfer for Real Groups

15:30-16:00

Yoichi Mieda, Kyoto University, Japan

Zelevinsky Involution and l-adic Cohomology of Rapoport-Zink Spaces

Session 16: Operator Algebras and Harmonic Analysis (Room: 106)

Organizers: Anthony Lau, Zhong-Jin Ruan

14:00-14:30

Quanhua Xu, Wuhan University, China and University of Franche-Comté, France
Recent Development of Analysis on Noncommutative Tori
14:30-15:00
Kunyu Guo, Fudan University, China
Operator Theoretic Analogue for Lehmer's Problem
15:00-15:30
Nico Spronk, University of Waterloo, Canada
p-Variations of Fourier Algebras on Compact Groups

Session 17: Optimization (Room: 110)
Organizers: Regina Burachik, Xiaojun Chen, Alejandro Jofré, Hector Ramirez
14:00-14:40
Yanqin Bai, Shanghai University, China
Linear Conic Programming and Interior-point Algorithms
14:40-15:20
Julio López, Universidad Diego Portales, Chile
A Feasible Direction Algorithm for Nonlinear Second-Order Cone Optimization Problems
15:20-16:00
Hector Ramirez, Universidad de Chile, Chile
Second-order Analysis in Conic Programming: Applications to Stability

Session 18: Probability (Room: 103)
Organizers: Shige Peng, Martin Barlow
14:00-14:30
Mark Holmes, The University of Auckland, New Zealand
Scaling Limits of Interacting Particle Systems in High Dimensions
14:30-15:00
Mingshang Hu, Shandong University, China
TBA
15:00-15:30
Rongfeng Sun, National University of Singapore, Singapore
Symmetric Rearrangements around Infinity with Applications to Levy Processes
15:30-16:00
Zhen-Qing Chen, University of Washington, USA
Stable Processes with Drift

Session 19: Representation Theory and Categorification (Room: 107)
Organizers: Xuhua He, Joel Kamnitzer, Tony Licata, James Parkinson, Arun Ram
14:00-15:00
Kari Vilonen, Northwestern University, USA
Hodge Theory and Representation Theory
15:00-15:30
Kai Meng Tan, National University of Singapore, Singapore
Decomposition Numbers for the Symmetric Groups and Schur Algebras
15:30-16:00
Clifton Cunningham, University of Calgary, Canada
Geometric Reciprocity for Algebraic Tori over Non-Archimedean Local Fields

Session 20: Singularities in Geometry and Topology (Room: 221)
Organizers: Guangfeng Jiang, Laurentiu Maxim, Mutsuo Oka, Jose Seade
14:00-14:50
David Massey, Northeastern University, USA
Improved Bounds on the Ranks of the Milnor Fiber Cohomology
15:00-15:25
Min Yan, Hong Kong University of Science and Technology, Hong Kong
Topological Classification of Multiaxial U(n)-Actions
15:30 -16:00
Junda Chen, Fudan University, China
Orbit Configuration Spaces of Small Covers and Quasitoric Manifolds

Session 21: Symplectic Geometry and Hamiltonian Dynamics (Room: 216)
Organizers: Yakov Eliashberg, Yiming Long

14:00-14:50
Kaoru Ono, RIMS, Kyoto University, Japan
Anti-symplectic Involution and Floer Theory
15:00-15:50
An-min Li, Sichuan University, China
The Extremal Kahler Metrics on Toric Manifolds

Session 22: Symplectic Geometry and Mathematical Physics (Room: 222)
Organizers: Xiaobo Liu, Huijun Fan
14:00-14:45
Ludmil Katzarkov, University of Miami, USA and University of Vienna, Austria
Categories and Dynamical Systems
14:50-15:35
Bohui Chen, Sichuan University, China
Virtual Neighborhood Techniques in Gromov-Witten Theory
15:35-16:20
Hiroshi Iritani, Kyoto University, Japan
Fock Sheaf of Givental Quantization

Session 23: Triangulated Categories in Representation Theory of Algebras (Room: 214)
Organizers: Ragnar-Olaf Buchweitz, Shiping Liu, Claus Michael Ringel, Pu Zhang
14:00-14:45
Luchezar L. Avramov, University of Nebraska-Lincoln, USA
TBA
14:50-15:20
Ryo Takahashi, Nagoya University,Japan
Exact Categories over Cohen-Macaulay Rings
15:25-15:55
Changchang Xi, Capital Normal University, China
Rigid Morphisms, Exact Pairs and Applications

16:00-16:30
Coffee Break

16:30-17:30

Session 1: A Glimpse of Stochastic Dynamics (Room: 208)
Organizers: Jinqiao Duan, Hongjun Gao
16:30-17:00
Yong Liu, Peking University, China
On Time Regularity of SPDE Driven by Levy Noise in Hilbert Spaces
17:00-17:30
Qi Zhang, Fudan University, China
Backward Stochastic Partial Differential Equations and Their Application to Stochastic Black-Scholes Formula

Session 2: Algebraic and Complex Geometry (Room: 207)
Organizers: Yujiro Kawamata, JongHae Keum
16:30-17:20
Keiji Oguiso, Osaka University, Japan and Korea Institute for Advanced Study, Korea
Smooth Quartic K3 Surfaces and Cremona Transformations

Session 3: Algebraic Topology and Related Topics (Room: 229)
Organizers: Alejandro Adem, Alan Jonathan Berrick, Craig Westerland
16:30-17:00
Dev P. Sinha, University of Oregon, USA
Cohomology of Symmetric and Alternating Groups
17:00-17:30
Dong Youp Suh, Korea Advanced Institute of Science and Technology, Korea
Classification of Complex Projective Towers Up to Dimension 8 and Cohomological Rigidity

Session 4: Applications of Harmonic Maps and Submanifold Theory (Room: 224)
Organizers: Yuxin Dong, Martin A. Guest, Wei Zhang
16:40-17:20
ShihShu Walter Wei, University of Oklahoma, USA
TBA

Session 5: Combinatorics and Discrete Mathematics (Room: 202)

Organizers: Andreas Dress, Jing Huang, Yaokun Wu

16:30-17:00

Xuding Zhu, Zhejiang Normal University, China

On-line List Colouring of Graphs

17:00-17:30

Pinar Heggernes, University of Bergen, Norway

Enumeration in Graph Classes

Session 6: Geometric Analysis (Room: 226)

Organizers: Jie Qing, Gang Tian, Xiaohua Zhu

16:30-17:00

Ivan Cheltsov, University of Edinburgh, UK

Affine Cones over Smooth del Pezzo Surfaces

17:00-17:30

Hong Huang, Beijing Normal University, China

Ricci Flow and 4-Manifolds with Positive Isotropic Curvature

Session 7: Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives (Room: 218)

Organizers: Nassif Ghoussoub, Manuel delPino, Juncheng Wei

16:30-17:00

Yong Liu, North China Electric Power University, China

Singly Periodic Solutions to the Allen-Cahn Equation and the Toda Lattice

17:00-17:30

Kelei Wang, Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, China

Monotonicity Formula and Liouville Theorems for Stable Solutions of Some Elliptic Problems

Session 8: Hyperbolic Conservation Laws and Related Applications (Room: 100)

Organizers: Feimin Huang, Dehua Wang, Ya-Guang Wang

16:30-17:00

Ronghua Pan, Georgia Institute of Technology, USA

Compressible Navier-Stokes Equations with Chapman Dissipation

17:00-17:30

Daoyuan Fang, Zhejiang University, China

Some Results about Compressible Oldroyd-B

Session 10: Kinetic Equations (Room: 220)

Organizers: Radjesvarane Alexandre, Benoit Perthame

16:30-17:00

Seung-Yeal Ha, Seoul National University, Korea

L^p-scattering and Uniform Stability of Kinetic Equations

17:00-17:30

Pierre-Emmanuel Jabin, University of Maryland, USA

New Regularity Estimates for Transport Equations

17:30-18:00

Radjesvarane Alexandre, French Naval Academy, France and Shanghai Jiao Tong University, China

On Some Kinetic Models for Bose Einstein Condensation

Session 11: Mathematical Fluid Dynamics and Related Topics (Room: 228)

Organizers: Dongho Chae, Yoshikazu Giga, Yasunori Maekawa, Tai-Peng Tsai

16:30-16:55

Ting Zhang, Zhejiang University, China

Global Strong Solution for Equations Related to the Incompressible Viscoelastic Fluids

17:00-17:25

Xiangdi Huang, Academy of Mathematics and System Sciences, CAS, China

Global Classical and Weak Solutions to the 3D Fully Compressible Navier-Stokes-Fourier System

Session 13: Measurable and Topological Dynamics (Room: 104)

Organizers: Alejandro Maass, Hitoshi Nakada, KyewonKoh Park, Xiangdong Ye

16:30-17:00

Seonhee Lim, Seoul National University, Korea

Subword Complexity and Sturmian Colorings of Trees

17:00-17:30

Xiongping Dai, Nanjing University, China

Chaotic Dynamics of Continuous-time Topological Semiflow on Polish Space

Session 14: Multiscale Analysis and Algorithms (Room: 102)

Organizers: Weinan E, Carlos Garcia-Cervera, Pingbing Ming

16:30-17:00

Mitchell Luskin, University of Minnesota, USA

TBA

17:00-17:30

Xiantao Li, Pennsylvania State University, USA

Atomic Level Interpretation of Fracture Criteria

Session 15: Number Theory and Representation Theory (Room: 105)

Organizers: Clifton Cunningham, Atsushi Ichino, Vinayak Vatsal

16:30-17:00

Moshe Adrian, University of Utah, USA

Rectifiers and the Local Langlands Correspondence

17:00-17:30

Chung Pang Mok, McMaster University, Canada

Endoscopic Classification of Automorphic Representations of Classical Groups

Session 16: Operator Algebras and Harmonic Analysis (Room: 106)

Organizers: Anthony Lau, Zhong-Jin Ruan

16:30-17:00

Michael Lamoureux, University of Calgary, Canada

Minimum Phase Operators and the Polya-Schur Problem

Session 17: Optimization (Room: 110)

Organizers: Regina Burachik, Xiaojun Chen, Alejandro Jofré, Hector Ramirez

16:30-17:00

Huifu Xu, City University of London, UK

Asymptotic Convergence Analysis for Distributional Robust Optimization and Equilibrium Problems

17:00-17:30

Alejandro Jofré, Universidad de Chile, Chile

The Robust Stability of Every Equilibrium in Economic Models of Exchange

Session 18: Probability (Room: 103)

Organizers: Shige Peng, Martin Barlow

16:30-17:00

Takashi Kumagai, Kyoto University, Japan

Quenched Invariance Principles for Random Walks and Random Divergence Forms in Random Media with a Boundary

17:00-17:30

Ryoki Fukushima, Kyoto University, Japan

Brownian Motion in a Heavy Tailed Poissonian Potential

Session 19: Representation Theory and Categorification (Room:107)

Organizers: Xuhua He, Joel Kamnitzer, Tony Licata, James Parkinson, Arun Ram

16:30-17:00

Julia Pevtsova, University of Washington, USA

Elementary Subalgebras of Modular Lie Algebras

17:00-17:30

Stephen Griffeth, Universidad de Talca, Chile

Vanishing Properties of Jack Polynomials

Session 20: Singularities in Geometry and Topology (Room: 221)

Organizers: Guangfeng Jiang, Laurentiu Maxim, Mutsuo Oka, Jose Seade

16:30 -17:20

Ricardo Uribe-Vargas, *Université de Bourgogne*, France

Characteristic Points, Fundamental Cubic Form and Euler Characteristic of Projective Surfaces

Session 21: Symplectic Geometry and Hamiltonian Dynamics (Room: 216)

Organizers: Yakov Eliashberg, Yiming Long

16:30-17:20

Yong-Geun Oh, University of Wisconsin-Madison, USA & IBS-Center for Geometry and Physics, Korea

Canonical Connection and Analysis of Contact Cauchy-Riemann Equation

Session 22: Symplectic Geometry and Mathematical Physics (Room: 222)

Organizers: Xiaobo Liu, Huijun Fan

16:30-17:15

Yakov Eliashberg, Stanford University, USA

Algebra of Legendrian Surgery

Session 23: Triangulated Categories in Representation Theory of Algebras (Room: 214)

Organizers: Ragnar-Olaf Buchweitz, Shiping Liu, Claus Michael Ringel, Pu Zhang

16:30-17:15

Pierre-Guy Plamondon, University of Paris-Sud, France

Cluster Categories and Independence Results for Exchange Graphs

17:25-17:55

Claus Michael Ringel, Bielefeld University, Germany and Shanghai Jiao Tong University, China

From Submodule Categories to Preprojective Algebras

Contributed Talks Group 3: Discrete Mathematics (Room: 219)

Chair: Xiao-Dong Zhang, Shanghai Jiao Tong University, China

16:30-16:50

Ju Zhou, Kutztown University of Pennsylvania, USA

Pancyclicity of 4-Connected $(K_{1,3}, Z_8)$*-free Graphs*

16:50-17:10

Congpei An, Jinan University, China

Numerical Verification Method for Well Conditioned Spherical t-Designs

17:10-17:30

Suhadi Wido Saputro, Institut Teknologi Bandung, Indonesia

On the Fractional Metric Dimension of Tree Graphs

Contributed Talks Group 5: Differential Equations (Room: 229)

Chair: Lei Zhang, Shanghai Jiao Tong University, China

16:30-16:50

Beixiang Fang, Shanghai Jiao Tong University, China

Global Stability of E-H Type Regular Refraction of Shocks on the Interface between Two Media

16:50-17:10

Fang Yu, Shanghai Jiao Tong University, China

Stability of Supersonic Contact Discontinuities for Three Dimensional Compressible Steady Euler Flows

17:10-17:30

Qin Wang, Shanghai Jiao Tong University, China

The Regularity of Semi-hyperbolic Patches at Sonic Lines for the Pressure Gradient Equation in Gas Dynamics

Wednesday, June 26

Morning Lectures: at Wen Zhi Hall

8:30-9:20
***Public Lecture*, Ronald Graham,** University of California, San Diego, USA
Computers and Mathematics: Problems and Prospects
Chair: Shige Peng, Shandong University, China

9:30-10:20
***Plenary Lecture*, Weinan E,** Peking University, China and Princeton University, USA
The Exact Renormalization Group Flow
Chair: Shige Peng, Shandong University, China

10:30-11:00
Coffee Break

11:00-11:50
***Plenary Lecture*, Weiping Zhang,** Nankai University, China
Geometric Quantization Formulas on Symplectic Manifolds
Chair: Yakov Eliashberg, Stanford University, USA

12:00-14:00
Lunch

14:00-17:30
Free afternoon

Thursday, June 27

Morning Lectures: at Wen Zhi Hall

8:30-9:20
***Plenary Lecture*, Martin Barlow**
University of British Columbia, Canada
Random Walks and Percolation
Chair: Doug Lind, University of Washington, USA

9:30-10:20
***Plenary Lecture*, Arun Ram,** University of Melbourne, Australia
Combinatorics, Representations, Homogeneous Spaces and Elliptic Cohomology
Chair: Doug Lind, University of Washington, USA

10:30-11:00
Coffee Break

11:00-11:50
***Plenary Lecture*, Jun-Muk Hwang,** Korea Institute for Advanced Study, Korea
Sphere Packings, Symplectic Lattices and Riemann Surfaces
Chair: JongHae Keum, Korea Institute for Advanced Study, Korea

12:00-14:00
Lunch

Afternoon Sessions: at Engineering Hall

14:00-16:00

Session 1: A Glimpse of Stochastic Dynamics (Room: 208)
Organizers: Jinqiao Duan, Hongjun Gao

14:00-14:30
Yong Xu
Northwestern Polytechnical University, China
The Availability of Logical Operation Induced by Dichotomous Noise for a Nonlinear Bistable System
14:30-15:00
Guillaume Bal, Columbia University, USA
TBA
15:00-15:30
Hassan Allouba, Kent State University, USA
TBA
15:30-16:00
Mickael Chekroun, University of Hawaii, USA
TBA

Session 2: Algebraic and Complex Geometry (Room: 207)
Organizers: Yujiro Kawamata, JongHae Keum
14:00-14:50
Sijong Kwak, Korea Advanced Institute of Science and Technology, Korea
Geometry and Syzygies in the First Linear Strand
15:00-15:50
Takehiko Yasuda, Osaka University, Japan
The Hilbert Scheme of Points and Extensions of Local Fields

Session 3: Algebraic Topology and Related Topics (Room: 229)
Organizers: Alejandro Adem, Alan Jonathan Berrick, Craig Westerland
14:30-15:00
Jie Wu, National University of Singapore, Singapore
On Simplicial Resolutions of Framed Links
15:00-15:30
Shengkui Ye, University of Oxford, UK
Rigidity of Matrix Groups

15:30-16:00
Craig Westerland, University of Melbourne, Australia
Homology of Hurwitz Spaces and the Cohen-Lenstra Heuristics

Session 5: Combinatorics and Discrete Mathematics (Room: 202)
Organizers: Andreas Dress, Jing Huang, Yaokun Wu
14:00-14:30
Brendan McKay, Australian National University, Australia
The Practice of Graph Isomorphism
14:30-15:00
Ryuhei Uehara, Japan Advanced Institute of Science and Technology, Japan
The Graph Isomorphism Problem on Geometric Graphs
15:00-15:30
Nikolai Dolbilin, Steklov Mathematics Institute of the Russian Academy of Sciences, Russia
Parallelohedra: From Minkowski and Voronoi to the Present Day
15:30-16:00
Eiichi Bannai, Shanghai Jiao Tong University, China
On Tight Relative t-Designs

Session 6: Geometric Analysis (Room: 226)
Organizers: Jie Qing, Gang Tian, Xiaohua Zhu
14:00-14:30
Zizhou Tang, Beijing Normal University, China
The First Eigenvalue of Minimal Submanifolds in a Unit Sphere
14:30-15:00
Sergio Almaraz, Universidade Federal Fluminense, Brazil
Convergence of Scalar-flat Metrics on Manifolds with Boundary under the Yamabe Flow
15:00-15:30
Bin Zhou, Peking University, China
A Class of Weingarten Curvature Measures
15:30-16:00
Zhou Zhang, University of Sydney, Australia
Ricci Curvature in Kahler-Ricci Flow

Session 7: Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives (Room: 218)
Organizers: Nassif Ghoussoub, Manuel delPino, Juncheng Wei
14:00-14:30
Yoshihiro Tonegawa, Hokkaido University, Japan
Existence and Regularity of Mean Curvature Flow with Transport Term
14:30-15:00
Congming Li, Shanghai Jiao Tong University, China and University of Colorado at Boulder, USA
Existence and Non-existence of Positive Solutions on the Hardy-Littlewood-Sobolev Type Systems
15:00-15:30
Yong Yu, The Chinese University of Hong Kong, Hong Kong, China
Gamma Convergence for Maxwell-Chern-Simons-Higgs Energy
15:30-16:00
Yiming Long, Nankai University, China
TBA

Session 8: Hyperbolic Conservation Laws and Related Applications (Room: 100)
Organizers: Feimin Huang, Dehua Wang, Ya-Guang Wang
14:00-14:30
Hai-Liang Li, Capital Normal University, China
Long Time Behaviors of Vlasov-Poisson-Boltzmann Equations
14:30-15:00
Yue-Jun Peng, Université Blaise Pascal, Clermont-Ferrand, France
Stability of Steady State Solutions for Euler-Maxwell Equations
15:00-15:30
Yi Wang, Chinese Academy of Sciences, China

TBA

15:30-16:00

Ming Mei, Champlain College Saint-Lambert and McGill University, Canada

Asymptotic Behavior of Solutions to Euler-Poisson Equations for Bipolar Hydrodynamic Model of Semiconductors

Session 9: Inverse Problems (Room: 219)

Organizers: Guillaume Bal, Jin Cheng, Gunther Uhlmann

14:00-14:30

Matti Lassas, University of Helsinki, Finland

TBA

14:30-15:00

Axel Osses, University of Chile, Chile

A Heat Source Reconstruction Formula from Single Internal Measurements Using a Family of Null Controls

15:00-15:30

Hongyu Liu, University of North Carolina, USA

TBA

15:30-16:00

Ting Zhou, Massachusetts Institute of Technology, USA

TBA

Session 11: Mathematical Fluid Dynamics and Related Topics (Room: 228)

Organizers: Dongho Chae, Yoshikazu Giga, Yasunori Maekawa Tai-Peng Tsai

14:00-14:50

Tastuo Iguchi, Keio University, Japan

Solvability of the Initial Value Problem to a Model System for Water Waves

15:00-15:50

Stephen Gustafson, University of British Columbia, Canada

Global Solutions of the Equivariant Heat-flow

Session 13: Measurable and Topological Dynamics (Room: 104)

Organizers: Alejandro Maass, Hitoshi Nakada, KyewonKoh Park, Xiangdong Ye

14:00-14:30

Piotr Oprocha, AGH University of Science and Technology, Poland

Shadowing Properties with Average Tracing of Pseudo-orbits

14:30-15:00

Yong Moo Chung, Hiroshima University, Japan

Large Deviation Principle for Chaotic Dynamical Systems

15:00-16:00

Guohua Zhang, Fudan University, China

Local Weak Mixing in Dynamical Systems

Session 14: Multiscale Analysis and Algorithms (Room: 102)

Organizers: Weinan E, Carlos Garcia-Cervera, Pingbing Ming

14:00-14:30

Claude Le Bris, École des Ponts ParisTech, France

TBA

14:30-15:00

Xu Yang, University of California, Santa Barbara, USA

A Path Way Based Mean Field Model for E. coli Chemotaxis

15:00-15:30

Olof Runborg, KTH Royal Institute of Technology, Sweden

Multiscale Methods for Wave Propagation Problems

15:30-16:00

Ruo Li, Peking Univeristy, China

From Discrete Velocity Model to Moment Method

Session 15: Number Theory and Representation Theory (Room: 105)

Organizers: Clifton Cunningham, Atsushi Ichino, Vinayak Vatsal

14:00-14:30

Shunsuke Yamana, Kyushu University, Japan

L-functions and Theta Correspondence

14:30-15:00

Loren Spice, Texas Christian University, USA

Stability and Sign Changes in p-adic Harmonic Analysis

15:00-15:30

Binyong Sun, Academy of Mathematics and Systems Science, CAS, China

Conservation Relations for Local Theta Correspondence

15:30-16:00

Masato Kurihara, Keio University, Japan

On the Structure of Selmer Groups

Session 16: Operator Algebras and Harmonic Analysis (Room: 106)

Organizers: Anthony Lau, Zhong-Jin Ruan

14:00-14:30

Huaxin Lin, University of Oregon, USA

Kishimoto's Conjugacy Theorems in Simple C-algebras of Tracial Rank One*

14:30-15:00

Ngai-Ching Wong, National Sun Yat-sen University, Taiwan

Zero Products and Norm Preserving Orthogonally Additive Homogeneous Polynomials on C-algebras*

15:00-15:30

Chi-Keung Ng, Nankai University, China

Spectral Gap Actions and Invariant States

15:30-16:00

Ebrahim Samei, University of Saskatchewan, Canada

Extending Derivations to Dual Banach Algebras

Session 17: Optimization (Room: 110)

Organizers: Regina Burachik, Xiaojun Chen, Alejandro Jofré, Hector Ramirez

14:00-14:40

Zhiping Chen, Xi'an Jiaotong University, China

Stability of Two-stage Stochastic Programs with Quadratic Continuous Recourse

14:40-15:20

Vera Roshchina, University of Ballarat, Australia

Facially Exposed Cones Are Not Always Nice

15:00-16:00

Miguel Carrasco, Universidad de los Andes, Chile

Design of Robust Truss Structures for Minimum Weight Using the Sequential Convex Approximation Method

Session 18: Probability (Room: 103)

Organizers: Shige Peng, Martin Barlow

14:00-14:30

Dayue Chen, Peking University, China

The Motion of a Tagged Particle in the Simple Exclusion Process

14:30-15:00

Jaime San Martin, University of Chile, Chile

Ultrametric Potentials

15:00-15:30

Qi-Man Shao, The Chinese University of Hong Kong, Hong Kong, China

From Stein's Method to Self-normalized Moderate Deviations

15:30-16:00

Panki Kim, Seoul National University, Korea

Parabolic Littlewood-Paley Inequality for $\phi(-\Delta)$-type Operators and Applications to Stochastic Integro-differential Equations

Session 19: Representation Theory and Categorification (Room:107)

Organizers: Xuhua He, Joel Kamnitzer, Tony Licata, James Parkinson, Arun Ram

14:00-15:00

Weiqiang Wang, University of Virginia, USA

Globalizing Crystal Basis for Quantum Superalgebras

15:00-15:30

Alexander Molev, University of Sydney, Australia

Center at the Critical Level and Commutative Subalgebras

15:30-16:00

Paul Sobaje, University of Melbourne, Australia

Support Varieties for Reductive Groups

Session 20: Singularities in Geometry and Topology (Room: 221)
Organizers: Guangfeng Jiang, Laurentiu Maxim, Mutsuo Oka, Jose Seade
14:00-14:25
Osamu Saeki, Kyushu University, Japan
Broken Lefschetz Fibrations and Their Moves
14:30-14:55
Masahiko Yoshinaga, Hokkaido University, Japan
Milnor Fibers of Real Line Arrangements
15:00-15:25
Vu The Khoi, Hanoi Institute of Mathematics, Vietnam
TBA
15:30-15:55
Kiyoshi Takeuchi, University of Tsukuba, Japan
Geometry of Non-tame Polynomial Maps

Session 21: Symplectic Geometry and Hamiltonian Dynamics (Room: 216)
Organizers: Yakov Eliashberg, Yiming Long
14:00-14:50
ViktorGinzburg, University of California, Santa Cruz, USA
Mean Euler Characteristic: the Degenerate Case
15:00-15:50
Xijun Hu, Shandong University, China
The Hill-type Formula and Krein-type Trace Formula

Session 22: Symplectic Geometry and Mathematical Physics (Room: 222)
Organizers: Xiaobo Liu, Huijun Fan
14:00-14:45
Alejandro Adem, University of British Columbia, Canada
A Classifying Space for Commutativity
15:00-15:45
Paul Norbury, University of Melbourne, Australia
Orbifold Hurwitz Numbers and Eynard-Orantin Invariants

Session 23: Triangulated Categories in Representation Theory of Algebras (Room: 214)
Organizers: Ragnar-Olaf Buchweitz, Shiping Liu, Claus Michael Ringel, Pu Zhang
14:00-14:45
Henning Krause, Bielefeld University, Germany
Cohomological Length Functions
14:50-15:20
Christof Geiss, Universidad Nacional Autónoma de México, México
The Representation Type of Non-degenerate QPs
15:25-15:55
Thomas Bruestle, Bishops's University and Université de Sherbrooke, Canada
The Decorated Mapping Class Group of a Marked Surface

Contributed Talks Group 1: Geometry and Analysis (Room:224)
Chair: Deliang Xu, Shanghai Jiao Tong University, China
14:00-14:20
Feng Rong, Shanghai Jiao Tong University, China
On Automorphism Groups of Hua Domains
14:20-14:40
Peng Wu, Cornell University, USA
On the Potential Function of Gradient Steady Ricci Solitons
14:40-15:00
Paul Tupper, Simon Fraser University, Canada
Diversities and the Geometry of Hypergraphs
15:00-15:20
Yuan-Jen Chiang, University of Mary Washington, USA
Developments of Harmonic Maps into Biharmonic Maps
15:20-15:40

Xiangjin Xu, Binghamton University, USA
New Heat Kernel Estimates on Manifolds with Negative Ricci Curvature Lower Bound
15:40-16:00
Rui Liu, Nankai University, China
Cb-frames and the Completely Bounded Approximation Property for Operator Spaces

Contributed Talks Group 2: Algebra and Number Theory (Room: 220)
Chair: Hongze Li, Shanghai Jiao Tong University, China
14:00-14:20
Yuehui Zhang, Shanghai Jiao Tong University, China
Triangulated Categories from Categories of Special Exact Sequences
14:20-14:40
Liping Li, University of California, Riverside, USA
A Generalized Koszul Theory
14:40-15:00
Shuvra Gupta, University of Iowa, USA
Realising Galois Groups via Galois Representations
15:00-15:20
Yeansu Kim, Purdue University, USA
L-functions from Langlands-Shahidi Method for GSpin Groups and the Generic Arthur L-packet Conjecture
15:20-15:40
Igor Bakovic, University of Warsaw, Poland
Categorification in Topology, Geometry and Combinatorics
15:40-16:00
Hirotaka Koga, University of Tsukuba, Japan
Derived Equivalences and Gorenstein Dimension

Contributed Talks Group 5: Differential Equations (Room: 229)
Chair: Chunjing Xie, Shanghai Jiao Tong University, China
14:00-14:20
Min Ding, Shanghai Jiao Tong University, China
Some Piston Problems in Fluid Dynamics
14:20-14:40
Cheng-Jie Liu, Shanghai Jiao Tong University, China
Stability of Boundary Layers for the Non-isentropic Compressible Circularly Symmetric 2D Flow
14:40-15:00
Wei Yan, Institute of Applied Physics and Computational Mathematics, China
Blowup of Classical Solutions to the Compressible Navier-Stokes Equations
15:00-15:20
Fengquan Li, Dalian University of Technology, China
Overdetermined Boundary Value Problems with Strongly Nonlinear Elliptic PDE
15:20-15:40
Yun-Ho Kim, Sangmyung University, Korea
On Quasilinear Elliptic Equations with Variable Exponents
15:40-16:00
Linglong Du, National University of Singapore, Singapore
Over-compressive Shock Profile Associated with a Simplified System from MHD

16:00-16:30
Coffee Break

16:30-17:30

Session 2: Algebraic and Complex Geometry (Room: 207)
Organizers: Yujiro Kawamata, JongHae Keum
16:30-17:20
Meng Chen, Fudan University, China
Some Birationality Criteria on 3-folds with $p_g>1$

Session 5: Combinatorics and Discrete Mathematics (Room: 202)
Organizers: Andreas Dress, Jing Huang, Yaokun Wu
16:30-17:00
Jing Huang, University of Victoria, Canada
The Lexicographic Method
17:00-17:30
Michel Habib, University Paris Diderot - Paris VII, France
New Trends for Graph Searches

Session 7: Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives (Room: 218)
Organizers: Nassif Ghoussoub, Manuel delPino, Juncheng Wei
16:30-17:00
Hsin-Yuan Huang, National Sun Yat-sen University, Taiwan
On the Entire Radial Solutions Arising in Chern-Simons Equations
17:00-17:30
Ignacio Guerra, Universidad de Santiago de Chile, Chile
Solutions for a Semilinear Elliptic Equation in Dimension Two with Supercritical Growth

Session 8: Hyperbolic Conservation Laws and Related Applications (Room: 100)
Organizers: Feimin Huang, Dehua Wang, Ya-Guang Wang
16:30-17:00
Wen Shen, Pennsylvania State University, USA
Traveling Waves for Slow Erosion
17:00-17:30
Quansen Jiu, Capital Normal University, China
The Cauchy Problem to the Kazhikhov-Vaigant Model in Compressible Flow

Session 9: Inverse Problems (Room: 219)
Organizers: Guillaume Bal, Jin Cheng, Gunther Uhlmann
16:30-17:00
Lassi Paivarinta, University of Helsinki, Finland
TBA
17:00-17:30
Jun Zou, The Chinese University of Hong Kong, Hong Kong, China
Some Efficient Domain Decomposition Methods for a Class of Inverse Problems

Session 11: Mathematical Fluid Dynamics and Related Topics (Room: 228)
Organizers: Dongho Chae, Yoshikazu Giga, Yasunori Maekawa Tai-Peng Tsai
16:30-16:55
Satoshi Masaki, Hiroshima University, Japan
Classical Limit of Some Quantum Euler Equations

Session 14: Multiscale Analysis and Algorithms (Room: 102)
Organizers: Weinan E, Carlos Garcia-Cervera, Pingbing Ming
16:30-17:00
Weiguo Gao, Fudan University, China
Solving Nonlinear Eigenvalue Problem in Resonant Tunneling Diodes
17:00-17:30
Jianfeng Lu, Duke University, USA
Convergence of Force-based Atomistic-to-continuum Methods

Session 15: Number Theory and Representation Theory (Room: 105)
Organizers: Clifton Cunningham, Atsushi Ichino, Vinayak Vatsal
16:30-17:00
Gordan Savin, University of Utah, USA
Twisted Bhargava Cubes

Session 19: Representation Theory and Categorification (Room: 107)
Organizers: Xuhua He, Joel Kamnitzer, Tony Licata, James Parkinson, Arun Ram
16:30-17:30

Aaron Lauda, University of Southern California, USA
Knot Invariants and Their Categorifications via Howe Duality

Session 20: Singularities in Geometry and Topology (Room: 221)
Organizers: Guangfeng Jiang, Laurentiu Maxim, Mutsuo Oka, Jose Seade
16:30-16:55
José Luis Cisneros-Molina, Universidad Nacional Autónoma de México, México
On the Topology of Real Analytic Maps
17:00-17:25
Donghe Pei
Northeast Normal University, China
Singularities of Several Geometric Objects Related to Null Curves in Minkowski 3-space

Session 21: Symplectic Geometry and Hamiltonian Dynamics (Room: 216)
Organizers: Yakov Eliashberg, Yiming Long
16:30-17:20
Urs Frauenfelder, Seoul National University, Korea
Contacting the Moon

Session 22: Symplectic Geometry and Mathematical Physics (Room: 222)
Organizers: Xiaobo Liu, Huijun Fan
16:30-17:15
Todor Milanov, Kavli Institute for the Physics and Mathematics of the Universe, Japan
The Eynard-Orantin Recursion in Singularity Theory

Session 23: Triangulated Categories in Representation Theory of Algebras (Room: 214)
Organizers: Ragnar-Olaf Buchweitz, Shiping Liu, Claus Michael Ringel, Pu Zhang
16:30-17:15
Helmut Lenzing, Paderborn University, Germany
Invariant Flags for Nilpotent Operators, and Weighted Projective Lines
17:20-17:50
Bin Zhu, Tsinghua University, China
T-structures and Torsion Pairs in a 2-Calabi-Yau Triangulated Category

Contributed Talks Group 1: Geometry and Analysis (Room: 224)
Chair: Lihe Wang, Shanghai Jiao Tong University, China
16:30-16:50
Ming Shen, Fuzhou University, China
Variable Equation of State for a Dark Energy Model with Linearly Varying Deceleration Parameter
16:50-17:10
Shengda Hu, Wilfrid Laurier University, Canada
Hamiltonian Group of Self Product
17:10-17:30
Yi Huang, The University of Melbourne, Australia
A McShane-type Identity *for Closed Surfaces*

Contributed Talks Group 2: Algebra and Number Theory (Room: 220))
Chair: Mikhail Tyaglov, Shanghai Jiao Tong University, China
16:30-16:50
Natella Antonyan, Techologico de Monterrey, CCM, Mexico
Universal Objects for Free G-spaces
16:50-17:10
Jongyook Park, University of Science and Technology of China, China
On Symmetric Association Scheme with $k_1=3$ *and* $m_i=3$

Contributed Talks Group 5: Differential Equations (Room 229)
Chair: Beixiang Fang, Shanghai Jiao Tong University, China
16:30-16:50

Fang Wang, Princeton University, USA
On the Radiation Field for Wave Equations

16:50-17:10

Tsing-San Hsu, Chang Gung University, Taiwan
Multiplicity of Positive Solutions for a p-q-Laplacian Equation with Critical Nonlinearities

17:10-17:30

Lei Yu, SISSA, Italy
Global Structure of Admissible BV Solutions to Strictly Hyperbolic Conservation Laws in One Space Dimension

Friday, June 28

Morning Lectures: at Wen Zhi Hall

8:30-9:20
***Plenary Lecture*, Vaughan Jones,**
Vanderbilt University, USA
The Classification of Subfactors of Small Index
***Chair*:** Yujiro Kawamata, University of Tokyo, Japan

9:30-10:20
***Plenary Lecture*, Matlide Marcolli,**
California Institute of Technology, USA
Moduli Spaces and the Field with One Element
Chair: Yujiro Kawamata, University of Tokyo, Japan

10:30-11:00
Coffee Break

Friday Morning Talks: at Engineering Hall

11:00-12:00

Session 9: Inverse Problems (Room: 219)
Organizers: Guillaume Bal, Jin Cheng, Gunther Uhlmann
11:00-11:30
Plamen Stefanov, Purdue University, USA
Local Lens Rigidity
11:30-12:00
Jin Kenn Seo, Yongsei University, Korea
Recent Progress in Electrical Tissue Property MRI

Session 14: Multiscale Analysis and Algorithms (Room: 102)
Organizers: Weinan E, Carlos Garcia-Cervera, Pingbing Ming
11:00-11:30
Xiao-Ping Wang, Hong Kong University of Science and Technology, Hong Kong, China
Modeling and Simulation of Three-component Flows on Solid Surface
11:30-12:00
Weiqing Ren, National University of Singapore and Institute of High Performance Computing, Singapore
The Growing String Method for Saddle Point Search

Session 20: Singularities in Geometry and Topology (Room: 221)
Organizers: Guangfeng Jiang, Laurentiu Maxim, Mutsuo Oka, Jose Seade
11:00-11:25
Laurentiu Paunescu, The University of Sydney, Australia
Newton-Puiseux Analysis
11:30-11:55
Mutsuo Oka, Tokyo University of Science, Japan
Intersection Theory on Mixed Curves

Session 22: Symplectic Geometry and Mathematical Physics (Room: 222)
Organizers: Xiaobo Liu, Huijun Fan
11:00-12:00
Jian Zhou, Tsinghua University, China
Gopakumar-Vafa Invariants of Local Calabi-Yau 3-Folds

Session 23: Triangulated Categories in Representation Theory of Algebras (Room: 214)
Organizers: Ragnar-Olaf Buchweitz, Shiping Liu, Claus Michael Ringel, Pu Zhang
11:00-11:30

Quanshui Wu, Fudan University, China
Some Results Related to Poisson (co)Homology
11:30-12:00
Jiaqun Wei, Nanjing Normal University, China
Toward Repetitive Equivalences

Contributed Talks Group 1: Geometry and Analysis (Room: 224)
Chair: Yihu Yang, Shanghai Jiao Tong University, China
11:00-11:20
Jagjit Singh Matharu, Guru Nanak Dev University, India
Some Inequalities for Unitarily Invariant Norms
11:20 -11:40
Luis Manuel Tovar Sanchez, Instituto Politecnico Nacional, Mexico
Weighted Harmonic Spaces
11:40-12:00
Massoud Amini, Institute for Research in Fundamental Sciences, Iran
Bounded Operators on Hilbert C^*-modules

Contributed Talks Group 4: Computational Mathematics & Optimization (Room: 216)
Chair: Xiaoqun Zhang, Shanghai Jiao Tong University, China
11:00-11:20
Wei Weng, Waseda University, Japan
Application of MILP to Solve Complex Scheduling Problems
11:20-11:40
Pablo Zafra, Kean University, U.S.A.
Calculating Areas and Volumes with Rotated Axis
11:40-12:00
Chang Yang, Université Claude Bernard Lyon 1, France
Efficient Numerical Method for Boundary Conditions of Kinetic Equations

Contributed Talks Group 5: Differential Equations (Room:229)
Chair: Yachun Li, Shanghai Jiao Tong University, China
11:00-11:20
Jianzhong Su, University of Texas at Arlington, USA
Dynamics in Immune Reactions during Wound Healing Processes
11:20-11:40
Bin Cheng, University of Surrey, UK
Analysis of Some Nonlinear PDEs from Multi-scale Geophysical Applications
11:40-12:00
Aimin Huang, Indiana University, USA
The Linear Hyperbolic Initial Boundary Value Problems in a Domain with Corners

12:00-14:00
Lunch

Afternoon Sessions: at Engineering Hall

14:00-16:00

Session 5: Combinatorics and Discrete Mathematics (Room: 202)
Organizers: Andreas Dress, Jing Huang, Yaokun Wu
14:00-14:30
Mikhail Tyaglov, Shanghai Jiao Tong University, China
A Class of Periodic Continued Fractions and Factorization in Modular Group
14:30-15:00
David Bryant, University of Otago, New Zealand and Simon Fraser University, Canada
From Metrics to Diversities
15:00-15:30
Stefan Grünewald, CAS-MPG Partner Institute and Key Lab for Computational Biology (PICB), China
Slim Systems of Binary Phylogenetic Trees
15:30-16:00

Andreas Dress, CAS-MPG Partner Institute and Key Lab for Computational Biology (PICB), China

What is and to Which End Does One Study Phylogenetic Combinatorics?

Session 7: Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives (Room: 218)

Organizers: Nassif Ghoussoub, Manuel del Pino, Juncheng Wei

14:00-14:30

Shin-Hwa Wang, National Tsing Hua University, Taiwan

Global Bifurcation Diagrams and Exact Multiplicity of Positive Solutions for a One-dimensional Prescribed Mean Curvature Problem Arising in MEMS

14:30-15:00

Qiuping Liu

TBA

Session 9: Inverse Problems (Room: 219)

Organizers: Guillaume Bal, Jin Cheng, Gunther Uhlmann

14:00-14:30

Xu Zhang, Sichuan University, China

Stochastic Controllability

15:00-15:30

Lingyun Qiu, Purdue University, USA

Inverse Boundary Value Problems for Time-harmonic Acoustic Waves: Conditional Stability and Iterative Reconstruction

15:30-16:00

Shuai Lu, Fudan University, China

On the Inverse Problems for the Coupled Continuum Pipe Flow Model for Flows in Karst Aquifers

16:30-17:00

Jin Cheng, Fudan University, China

TBA

Session 14: Multiscale Analysis and Algorithms (Room: 102)

Organizers: Weinan E, Carlos Garcia-Cervera, Pingbing Ming

14:00-14:30

Pingbing Ming, Institute of Computational Mathematics, CAS, China

Ghost Forces for Multiscale Coupling Methods in Solids

14:30-15:00

Carlos J. García-Cervera, University of California, Santa Barbara, USA

Quantum, Kinetic and Hydrodynamic Descriptions on Spin Transfer Torque

15:00-15:30

Wei Cai, University of North Carolina at Charlotte, USA and Shanghai Jiao Tong University, China

A Hybrid Method for Solving Laplace Equations with Dirichlet Data Using Local Boundary Integral Equations and Random Walks

Session 20: Singularities in Geometry and Topology (Room: 221)

Organizers: Guangfeng Jiang, Laurentiu Maxim, Mutsuo Oka, Jose Seade

14:00-14:25

Haydée AguilarCabrera, National Aotonomous University of Mexico, Mexico

The Topology of Real Suspension Singularities of Type $f\bar{g} + z^n$

14:30-14:55

Laurentiu Maxim, University of Wisconsin-Madison, USA

Characteristic Classes of Singular Toric Varieties

15:00-15:25

Rong Du，East China Normal University, China

On Griffiths Numbers for Higher Dimensional Isolated Singularities

15:25 -15:55

Terence Gaffney, Northeastern University, USA

Equisingularity and Integral Closure of Ideals and Modules: Two Partners in a Dance

Session 22: Symplectic Geometry and Mathematical Physics (Room: 222)

Organizers: Xiaobo Liu, Huijun Fan

14:00-14:45

Bumsig Kim, Korea Institute for Advanced Study, Korea

Quasimap Invariants and Mirror Maps

15:00-16:00

Youjin Zhang, Tsinghua University, China

On a Certain Generalization of Virasoro Constraints for Frobenius Manifolds

Session 23: Triangulated Categories in Representation Theory of Algebras (Room: 214)

Organizers: Ragnar-Olaf Buchweitz, Shiping Liu, Claus Michael Ringel, Pu Zhang

14:00-14:30

Lidia Angeleri Huegel, University of Verona, Italy

Derived Simple Algebras

14:35-15:05

Xiao-Wu Chen, University of Science and Technology of China, China

Singular Equivalences with Examples

15:10-15:55

Ragnar-Olaf Buchweitz, University of Toronto Scarborough, Canada

Autoequi valences under Derived Equivalences

Contributed Talks Group 1: Geometry and Analysis (Room: 224)

Chair: Chunqin Zhou, Shanghai Jiao Tong University, China

14:00-14:20

Xiaobin Li, Southwest Jiaotong University, China

A New Gluing Recursive Relation for Linear Sigma Model of P^1*-orbifold*

14:20-14:40

Sergey Antonyan, National University of Mexico, Mexico

Gromov-Hausdorff Hyperspaces of R^n

Contributed Talks Group 4: Computational Mathematics & Optimization (Room: 216)

Chair: Min Tang, Shanghai Jiao Tong University, China

14:00-14:20

Pengtao Sun, University of Nevada Las Vegas, USA

Full Eulerian Finite Element Methods for Fluid-structure Interaction Problem in Fictitious Domain and Phase Field Approaches

14:20-14:40

Jintao Cui, University of Arkansas at Little Rock, USA

An Analysis of HDG Methods for the Helmholtz Equation

14:40-15:00

Ning Ruan, University of Ballarat, Australia

Efficient Duality Method to a Class of Global Optimizations Problems with Nonconvex Objective Function

Contributed Talks Group 5: Differential Equations (Room: 229)

Chair: Shijin Deng, Shanghai Jiao Tong University, China

14:00-14:20

Ying Wang, University of Minnesota, USA

The Half Line versus Finite Domain Problems of the Modified Buckley-Leverett Equation

14:20-14:40

XinAn Wang, Shanghai Jiao Tong University, China

Constructing Global Lyapunov Function for Complex Systems

14:40-15:00

Larry Wang, Southern Polytechnic State University, USA

Relationship between Omega-limit Sets and Minimal Sets

15:20-15:40

Baili Chen, Gustavus Adolphus College, USA

Nonlinear Impulsive Differential Equations Arising from Chemotherapeutic Treatment

2013 PRIMA

Abstracts

Abstracts are printed as submitted by the Author

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1 Public Lectures

Computers and mathematics: problems and prospects

Ron Graham
University of California, San Diego, USA
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There is no question that the recent advent of the modern computer has had a dramatic impact on what mathematicians do and on how they do it. However, there is increasing evidence that many apparently simple problems may in fact be forever beyond any conceivable computer attack. In this talk, I will describe a variety of mathematical problems in which computers have had, may have or will probably never have a significant role in their solutions.

Of triangles, gas, prices and men

Cédric Villani
Université de Lyon and Institut Henri Poincaré, France
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The story of mathematical progress coming from the accidental encounter of three different fields which seemed to have hardly anything in common.

2 Plenary Lectures

Random walks and percolation

Martin Barlow
University of British Columbia, Canada
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Around 1960 de Giorgi, Moser and Nash proved regularity for the heat equation associated with divergence form PDE:

$$\frac{\partial u}{\partial t} = Lu, \quad u = u(x,t), x \in \mathbf{R}^{\mathbf{d}}, t > 0. \qquad (1)$$

Here $L = \nabla a \nabla$, where $a = a_{ij}(x)$ is uniformly elliptic. In the special case when $a = \rho(x)I$, (1) describes heat flow in a medium of varying conductivity ρ, and uniformly elliptic means that ρ is bounded away from 0. If on the other hand $Z = \{x : \rho(x) = 0\} \neq \emptyset$, then the zero regions can form barriers, and the behaviour of solutions to (1) will depend on the detailed geometry of Z.
As an approach to problems of this kind, one can consider discrete approximations to (1). One such is percolation on the Euclidean lattice $\mathbf{Z}^d$, which was introduced by Broadbent and Hammersley in 1957. Let p be a fixed probability between 0 and 1. Each bond in $\mathbf{Z}^d$ is retained with probability p, and removed with probability $1-p$, independently of all the others. If p is larger than some critical value $p = p_c(d)$ then the resulting graph has a unique infinite connected component C. De Gennes in 1976 called the random walk on C the 'the ant in the labyrinth'. The problem is related to the heat equation, since if $p(n,x,y)$ is the probability that a random walker ('the ant'), starting at x, is at y at time n, then p satisfies a discrete version of (1).
The PDE techniques of Nash and Moser have proved very useful in these contexts. I will discuss recent progress on these models, and in particular will discuss the proof of Gaussian bounds for p_n, and a central limit theorem for the (rescaled) random walk.

The Mathematics of Crime

Andrea Bertozzi
University of California, Los Angeles, USA
bertozzi@math.ucla.edu

There is an extensive applied mathematics literature developed for problems in the biological and physical sciences. Our understanding of social science problems from a mathematical standpoint is less developed, but also presents some very interesting problems. This lecture uses crime as a case study for using applied mathematical techniques in a social science application and covers a variety of mathematical methods that are applicable to such problems. We will review recent work on agent based models, methods in linear and nonlinear partial differential equations, variational methods for inverse problems and statistical point process models. From an application standpoint we will look at problems in residential burglaries and gang crimes. Examples will consider both bottom up and top down approaches to understanding the mathematics of crime, and how the two approaches could converge to a unifying theory.

The exact renormalization group flow

Weinan E
Peking University, China and Princeton University, USA
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Renormalization and renormalization group is the most important theoretical advance in the second half of the last centrury in physics. At its heart is a mathematical tool for handling singularities, infinities and complex systems involving multiple scales. Yet at the mathematical level, it still remains to be somewhat of a mysterious, ad hoc and even dubious procedure. We will discuss our effort to develop the mathematical foundation of the exact renormalization group flow. We will start with some simple examples (central limit theorem, extreme statistics, homogenization) and then discuss applications to stochastic PDEs, quantum field theory and turbulent transport. This is joint work with Hao Shen, Yajun Zhou and Qingyun Sun.

Sphere packings, symplectic lattices and Riemann surfaces

Jun-Muk Hwang
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Symplectic lattices are lattices in Euclidean space with certain extra-symmetries associated to Hermitian forms. They correspond to principally polarized abelian varieties in algebraic geometry. Classical examples are given by period lattices of compact Riemann surfaces.
Our theme is the density of sphere packing for symplectic lattices. In their seminal work in 1994, Buser and Sarnak showed that peorid lattices of compact Riemann surfaces give remarkably poor sphere packing. Following Buser-Sarnak's work, many interesting relations between the density of sphere packing for symplectic lattices and algebro-geometric properties of corresponding abelian varieties have been discovered. We will give an overview of this subject with a report on a recent work on period lattices of Prym varieties, another important class of symplectic lattices arising from algebraic geometry.

The classification of subfactors of small index

Vaughan Jones
Vanderbilt University, USA
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Starting with the definition of a von Neumann algebra I will survey old and new developments in the index theory of subfactors which suggest that a complete classification of "nice" subfactors may be possible up to index 6. At index 6 certain wild phenomena begin even for the nice subfactors.

Web Markov skeleton processes and their applications

Zhi-Ming Ma
Academy of Mathematics and Systems Science, CAS, China
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Recently a new class of stochastic processes, Web Markov Skeleton Processes (WMSP), has been found to be very useful in the study of information retrieval on the Web. In our research we found that the framework of WMSP enjoys also many interesting theoretical properties by its own. In this talk I shall briefly review some of our work in this research direction. I shall introduce the notion of WMSP, compare it with the previous notion of Markov skeleton processes introduced and studied by Hou el.al., discuss the relation between WMSP and multivariate point processes, discuss in detail the properties of mirror semi-Markov processes, a new class of processes in WMSP family. At the end of my talk I shall briefly explore the applications of WMSP in modeling user browsing behaviour on the web.

Moduli spaces and the field with one element

Matilde Marcolli
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This lecture is based on joint work with Yuri Manin (arXiv:1302.6526). Using a point of view on geometry over the “field with one element" based on torifications, developed by López-Peña and Lorscheid, we describe a notion of constructible sets over F_1, given in terms of suitable differences of torifications with a positivity condition on the class in the Grothendieck ring. We then show that the operad of moduli spaces of genus zero curves with marked points can be endowed with descent data to F_1. We show that other moduli spaces generalizing the case of genus zero curves also give rise to operads defined over F_1.

Combinatorics, representations, homogeneous spaces and elliptic cohomology

Arun Ram
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This talk will give an elementary survey of recent developments in combinatorial representation theory, where input from stable homotopy theory and algebraic topology enters. The theory of p-compact groups founded by Dwyer and Wilkerson gives rise to homogeneous spaces that generalize the combinatorics of Lie theory, and the framework of generalized cohomology theories (elliptic cohomology and cobordism) provides new insight into classical intersection theory computations for Grassmannians and flag varieties. In both cases, the study of possible generalizations of the Weyl character formula, and their relation to Atiyah-Bott localization formulas provides useful motivation and insight. The combinatorial aspect provides powerful elementary models for all of these objects.

Searching the quantum symmetry

Yongbin Ruan
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During last thirty years, there has been a great deal of interactions between mathematics and physics. During these interactions, mathematician are often impressed by the magic formula and conjectures physicists can come up. At the same time, it is frustrating that we can not come up the similar formula and conjecture by our own. In the talk, I will illustrate how to apply a simple physical principal (quantization principal) to discover several new area of mathematics.

Geometric class field theory and existence conjecture of smooth ℓ-adic sheaves on varieties over finite fields

Shuji Saito
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A main result of this talk is a proof of the rank one case of an existence conjecture for smooth ℓ-adic sheaves on a smooth variety X over a finite field due to Deligne and Drinfeld. The conjecture says that a compatible system of smooth ℓ-adic sheaves on the curves on X, satisfying a certain boundedness condition for ramification at infinity, should arise from a smooth ℓ-adic sheaf on X. It may be viewed as an arithmetic analogue of a well-known fact in topology that the fundamental group of a CW complex is determined by its 2-skeleton. The problem is translated into the language of geometric class field theory, which describes the abelian fundamental group of X by Chow groups of zero cycles with modulus.

To give a more precise statement, let $\mathcal{S}_r(X)$ be the set of smooth ℓ-adic sheaves on X of rank r up to isomorphism and up to semi-simplification. Let $Cu(X)$ be the set of normalizations of integral curves on X. Let $\mathcal{S}k_r(X)$ be the set of systems $(V_Z)_{Z\in Cu(X)}$ with $V_Z \in \mathcal{S}_r(Z)$ such that

$$(V_Z)_{|Z\times_X Z'} = (V_{Z'})_{|Z\times_X Z'} \quad \text{for} \quad Z, Z' \in Cu(X).$$

Such a system is called a skeleton sheaf on X (closed points and curves on X are viewed as 1-skeleton and 2-skeleton of X respectively). The question is how to determine the image of the restriction map

$$\mathcal{S}_r(X) \to \mathcal{S}k_r(X),$$

i.e. when a skeleton sheaf on X glues to a smooth ℓ-adic sheaf on X. We explain a conjecture of Deligne (motivated by work of Drinfeld) on the problem which describes the image in terms of a ramification condition at infinity and prove the conjecture in case $r = 1$ using geometric class field theory.

Geometric quantization formulas on symplectic manifolds

Weiping Zhang
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We describe the theme of “Quantization commutes with reduction" on symplectic manifolds admitting a Hamiltonnian action of a compact Lie group, which on compact manifolds concerns the Guillemin-Sternberg conjecture and on noncompact manifolds concerns a conjecture of Vergne.

3 Special Sessions

Special Session 1
A Glimpse of Stochastic Dynamics

Perspectives in stochastic dynamics — modeling, analysis and computation

Jinqiao Duan
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Dynamical systems arising in engineering and science are often subject to random influences. The noisy processes may be Gaussian or non-Gaussian, which are modeled by Brownian motion or stable Levy motion, respectively. Non-Gaussianity of the noise manifests as nonlocality at a "macroscopic" level. Stochastic partial/ordinary differential equations with Brownian motion or Levy motion are appropriate models for these systems.
To understand dynamics under uncertainty, topological, geometric and analytical approaches are taken to examine the quantities that carry dynamical information and the structures that act as dynamical skeletons. In particular, within the analytical approaches, a quantity called scape probability is investigated and computed in order to describe transitions between dynamical regimes. This leads to consideration of a deterministic nonlocal partial differential equation. Moreover, the non-Gaussianity index in Levy motion is estimated by solving an inverse problem for this nonlocal partial differential equation, with the observation on escape probability.
The speaker will fist present an overview of available theoretical and numerical techniques for investigating stochastic dynamical systems, highlighting some delicate and profound impact of noise on dynamics. Then, he will focus on understanding stochastic dynamics by examining "escape probability in the context of prototypical examples in biophysical and physical settings.

Large deviations for the stochastic two-component b-family system

Hongjun Gao
Nanjing Normal University, China
gaohj@njnu.edu.cn

A Wentzell-Freidlin type large deviation principle is established for the stochastic two-component b-family system perturbed by a multiplicative noise. Firstly, the local well-posedness of the stochastic two-component b-family system is proved by regularization. Then, the large deviation principle is obtained by weak convergence method.

Refinements of the Shannon-McMillan-Breiman theorem

Guangyue Han
University of Hong Kong, Hong Kong, China
ghan@hku.hk

In this talk, under mild assumptions, we derive a law of large numbers, a central limit theorem with an error estimate, an almost sure invariance principle and a variant of the Chernoff bound in finite-state hidden Markov models. These limit theorems, which can be refinements of the celebrated Shannon-McMillan-Breiman theorem, are of interest in certain areas of information theory and statistics. Particularly, in information theory, these limit theorems can be used to calculate the capacity of a class of finite-state channels, and in statistics, they can used to derive the rate of convergence of the maximum likelihood estimator in finite-state hidden Markov models.

Convergent analysis of methods for non-linear filtering problems

Xiaoying Han
Auburn University, USA
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Optimal filtering problems are important in signal processing and related fields. Most of the time the optimal filter does not admit a closed-form expression, and various numerical methods are developed to solve the filtering problem. Among these methods, particle filter is a widely used tool for numerical prediction of complex systems when observation data are available. In this talk I will first give a brief introduction on particle filtering and present error analysis on the numerical formulation of particle filter. Then I will introduce an implicit filtering method, along with its convergence results.

Fast analysis of dynamic systems via Gaussian emulator

Samuel Kou
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Dynamic systems are used in modeling diverse behaviors in a wide variety of scientific areas. Current methods for estimating parameters in dynamic systems from noisy data are computationally intensive (for example, relying heavily on the numerical solutions of underlying differential equations). We propose a new inference method by creating a system driven by a Gaussian process to mirror the dynamic system. Auxiliary variables are introduced to connect this Gaussian system to the real dynamic system; and a sampling scheme is introduced to minimize the "distance" between these two systems iteratively. The new inference method also covers the partially observed case in which only certain components of the dynamic system are observed. The method offers a drastic saving of computational time and fast convergence while still retaining high estimation accuracy. We will illustrate the method by numerical examples.

On time regularity of SPDE driven by Levy noise in Hilbert spaces

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In this talk, we will present some new progresses on the time regulaity of generalized Ornstein-Uhlenbeck processes driven by Levy processes in Hilbert spaces. This talk is based on the following articles:
1. Brzezniak, Z., Goldys, B., Imkeller, P., Peszat, S., Priola, E., Zabczyk, J. *Time irregularity of generalized Ornstein-Uhlenbeck processes*, C. R. Acad. Sci. Paris, Ser. I 348(2010).
2. Liu, Y., Zhai, J.L. *A note on time regularity of generalized Ornstein-Uhlenbeck processes with cylindrical stable noise*, C. R. Acad. Sci. Paris, Ser. I 350(2012).
3. Peszat, S., Zabczyk, J. *Time regularity of solutions to linear equations with Levy noise in infinite dimensions*, Stochastic Processes and their Applications, 123(3), 2013.
4. Liu, Y., Zhai, J.L. *On time regularity of SPDE in Hilbert spaces*, 2013. Preprint.

Some results for discontinuous random dynamical systems

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In the talk, first of all, discontinuous random dynamical systems are introduced. Next, escape probability, asymptotic methods, Lyapunov exponents and topological equivalence, which are related with discontinuous random dynamical systems, are presented.

Fokker-Planck equations for nonlinear dynamical systems driven by non-Gaussian Lévy

processes

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The Fokker-Planck equations describe time evolution of probability densities of stochastic dynamical systems and are thus widely used to quantify random phenomena such as uncertainty propagation. For dynamical systems driven by non-Gaussian Lévy processes, however, it is difficult to obtain explicit forms of Fokker-Planck equations. In the present paper, Fokker-Planck equations are derived for nonlinear stochastic differential equations with non-Gaussian Lévy processes. The stochastic differential equations are considered in sense of both Ito and Marcus. A few examples are presented to illustrate the method.

Path-dependent optimal stochastic control and viscosity solution of associated Bellman equations

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Abstract In this paper we study the optimal stochastic control problem for a path-dependent stochastic system under a recursive path-dependent cost functional, whose associated Bellman equation from dynamic programming principle is a path-dependent fully nonlinear partial differential equation of second order. A novel notion of viscosity solutions is introduced by restricting the semi-jets on an α -Hölder space $\mathbf{C}^{\alpha}$ for $\alpha \in (0, \frac{1}{2})$. Using Dupire's functional Itô calculus, we prove that the value functional of the optimal stochastic control problem is a viscosity solution to the associated path-dependent Bellman equation. We expect that our viscosity solution is the value functional in a fairly general situation.

Self-similarity for some SPDEs

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This talk discusses self-similarity in distribution, which is called stochastic self-similarity, for some SPDEs. Two types of noise are considered, one is additive noise and the other is of some multiplicative noise. The existence of a self-similar solution is implied by the existence of a stationary solution under self-similar variables. We further show the attracting property of a self-similar solution. For the case additive noise, different attraction is considered by different approach. For the case of multiplicative noise, a diffusion approximation approach is applied.

The availability of logical operation induced by dichotomous noise for a nonlinear bistable system

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Instead of a continuous system driven by Gaussian white noise, logical stochastic resonance will be investigated in a nonlinear bistable system with two thresholds driven by dichotomous noise, which shows a phenomenon different from Gaussian white noise. We can realize two parallel logical operations by simply adjusting the values of these two thresholds. Besides, to quantify the reliability of obtaining the correct logic output, we numerically calculate the success probability, and effects of dichotomous noise on the success probability are observed, these observations show that the reliability of realizing logical operation in the bistable system can be improved through optimizing parameters of dichotomous noise.

Backward stochastic partial differential equations and their application to stochastic Black-Scholes formula

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The backward SPDEs, originated from the study of optimal control theory of SPDEs, can be applied to mathematical finance problems. We demonstrate their application to stochastic Black-Scholes formula, in a general setting to the parameters of the model. This application is based on our recent studies of the solvability to degenerate backward SPDEs without technical assumptions and their connection to forward-backward SDEs. The connection between backward SPDEs and forward-backward SDEs can also be regarded as an extension of Feynman-Kac formula to non-Markovian framework.

Malliavin matrix of degenerate PDE and gradient estimates

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In this talk, we present the bounded of the inverse for Malliavin Matrix of Degenerate PDE under a new condition, which is equivalent to the Hoermander condition as the coefficients are smooth. Also, the gradient estimatats for the semigroup is given.

Special Session 2
Algebraic and Complex Geometry

Pluricanonical maps and minimal models of threefolds

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Given a smooth projective variety, there are natural maps induced by the pluricanonical system. It is natural to ask when the pluricanonical maps stablized birationally. On the other hand, it is known that there exists a minimal model with terminal singularities. This model play the key ingredient in the study of geometry of threefolds. In this talk, we are going to demonstrate some application of birational geometry that one can obtain by comparing above two structures.

Some birationality criteria on 3-folds with $p_g > 1$

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We give some birationality criteria for φ_m ($m = 4, 5, 6, 7$) on general type 3-folds with $p_g \geq 2$ by means of an intensive classification.

Division algebras of transcendence degree two

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We study Artin's conjecture that division algebras of fractions of domains of dimension two are either rational,

ruled or finite over their centres. We have a proof of the conjecture that depends adds a few other conditions. We show that such domains over finite fields are finite over their centres. Then a deformation theory argument for orders over surfaces shows that we have Artin's conjectured classification. This is work in progress with Jason Bell.

Geometry and syzygies in the first linear strand

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Property $\mathbf{N}_{d,p}$, $d \geq 2$ for algebraic sets is defined (due to Eisenbud-Green-Hulek-Popescu) as follows: the j-th syzygies of the homogeneous coordinate ring are generated by elements of degree $\leq d-1+j$ for $1 \leq j \leq p$. When $d = 2$, linear syzygies of quadratic schemes have been focused for a long time. In this talk, we consider upper bounds and lower bounds of higher linear syzygies in the first linear strand of Betti tables for projective varieties in arbitrary characteristic. For this purpose, we establish fundamental inequalities which govern the relations between the graded Betti numbers of an algebraic set X and those of its inner projection X_q in the first linear strand. We obtain some natural sharp upper bounds and lower bounds for linear syzygies of any non-degenerate projective variety using these inequalities. We also classify what the extremal case and next-to-extremal case are. From the viewpoint of 'syzygies', this is a generalization of Castelnuovo and Fano's results on the number of quadrics containing a given variety.

Categorification of Donaldson-Thomas invariants and Gopakumar-Vafa invariants

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For a projective Calabi-Yau threefold, we can form the moduli of stable sheaves with prescribed Chern classes. The Donaldson-Thomas invariants of this Calabi-Yau threefolds are virtual degrees of these moduli spaces. In this talk, we will show that each of such moduli spaces admits perverse sheaves whose Euler classes are the Donaldson-Thomas invariants associated to the moduli spaces. Using such sheaves, we propose a new definition of Gopakumar-Vafa invariants of Calabi-Yau threefolds. This is a joint work with Young-Hoon Kiem.

Compacts

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For a flat map $f : X \longrightarrow Y$ of noetherian schemes one may define functors $\mathbf{L}f^*$, $\mathbf{R}f_*$, $f^\times$ and $f^!$ on appropriate derived categories of quasicoherent sheaves. In two recent papers, one by Avramov and Iyengar and the second by Avramov, Iyengar, Lipman and Nayak, the authors proved some remarkable formulas relating $f^!$, $f^\times$ and certain Hochschild homology objects. I will discuss a new approach to the results in terms of a map $\psi : f^\times \longrightarrow f^!$.

Smooth quartic K3 surfaces and Cremona transformations

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We discuss about the following question of Gizatullin: **Question.** Is an automorphism g of a smooth quartic K3 surface $S \subset \mathbf{P}^3$ derived from some birational automorphism, i.e., some Cremona transformation of the ambient space $\mathbf{P}^3$? More precisely, first I explain the following negative result: **Theorem 1.** *There is a smooth K3 surface S of Picard number 2 such that (i) $\mathrm{Aut}\,(S) \simeq \mathbf{Z}$ and (ii) No element $\mathrm{Aut}\,(S)$ other than id_S is derived from $\mathrm{Bir}\,(\mathbf{P}^3)$ in any embedding of S into $\mathbf{P}^3$.* Then, I explain the following positive result: **Theorem 2.** *There is a smooth K3 surface S of Picard number 2 such that (i) $\mathrm{Aut}\,(S) \simeq \mathbf{Z}$ and (ii) $\mathrm{Aut}\,(S)$ is derived from $\mathrm{Bir}\,(\mathbf{P}^3)$ in any embedding of S into $\mathbf{P}^3$.* As I will explain in my talk, examples in Theorem 2 are the ones found in a completely different context. However, they turn out to be very closely related with old works of Cayley, Snyder and Sharpe, as it is discovered by Festi, Garbagnati, van Geemen and vam Luijk quite recently. Being based on all of their works, I describe the automorphism group of these S both explicitly algebraically in terms of homogeneous coordinates and explicitly geometrically in terms of Sarkisov link.

The Hilbert scheme of points and extensions of local fields

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Two formulas very similar to each other appear in totally different contexts, the Hilbert scheme of points and Bhargava's formula for extensions of local fields. In this talk, I will explain the similarity as a special case of the wild McKay correspondence. The talk is based on a joint work with Melanie Matchett Wood.

Positivity of log canonical divisors and Mori/Brody hyperbolicity

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Let X be a complex projective variety of dimension n and D a reduced divisor with a decomposition $D = \sum_{i=1}^{r} D_i$, where the D_i's are reduced Cartier but not necessarily irreducible. The pair (X, D) is called Brody hyperbolic, respectively Mori hyperbolic, with respect to the decomposition if neither $X \backslash D$ nor $(\cap_{i\in I} D_i)\backslash(\cup_{j\in J} D_j)$ contains a non-constant holomorphic image, respectively algebraic image, of $\mathbb{C}$ for every partition of $\{1, \ldots, r\} = I \coprod J$. Assuming that the singularities of the pair (X, D) are sufficiently mild, we show that the log canonical divisor $K_X + D$ is numerically effective in the case of Mori hyperbolicity and that $K_X + D$ is ample provided that either $n < 4$ and D is non-empty or at least $n-2$ of the D_i's are ample in the case of Brody hyperbolicity. Our proof also gives simple geometric criteria for the log canonical divisor $K_X + D$ to be numerically effective or to be ample in the above (respective) cases and, under weaker geometric conditions, for $K_X + D$ to be pseudo-effective. This is a joint work with Steven Lu.

Special Session 3
Algebraic Topology and Related Topics

Homotopy colimits and commutative elements in Lie groups

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In this talk we describe homotopy invariants for a classifying space assembled from the commuting elements in a Lie group. This involves certain homotopy colimits over a topological poset and the resulting cohomology calculations for the unitary groups are expressed in terms of multisymmetric polynomials. This is joint work with Jose Gomez.

The topological Hochschild homology of Thom spectra as cyclotomic spectra

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One can construct a symmetric monoidal category of spectra by finding a way to internalize the external smash product. There is a corresponding category of "spaces", Quillen equivalent to the usual category of spaces but with a more interesting symmetric monoidal structure that mirrors the smash product of spectra. In this setting many constructions commute with passing to spectra. For example, taking the cyclic bar construction (in spectra) of a Thom spectrum is the same as taking the Thom spectrum of the cyclic bar construction (in "spaces"). What's new is that we can exploit an equivariant version of this to construct topological Hochschild homology of Thom spectra as genuine equivariant spectra with certain extra structure. This is part of work in progress with Blumberg, Gerhardt, Hill and Lawson.

Universal constructions on spaces of knots

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A basic unresolved question in traditional knot theory is 'what precisely does the Vassiliev spectral sequence tell us about the topology of the space of knots'? I will describe a current approach to this question, which takes as its input a fairly detailed understanding of the homotopy-type of the space of knots in S^3 coming from 3-manifold theory and the theory of operads.

Circle actions on 5-manifolds

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A circle action $S^1 \times M \to M$ on a manifold M is called regular if the quotient space $N = M/S^1$ is a manifold with $\dim N = \dim M - 1$. We classify all the 1-connected 5-manifolds that admit regular circle actions.

Cohomology of moduli spaces of manifolds

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I will discuss recent joint work with Oscar Randal-Williams on the cohomology of $B\mathrm{Diff}(M)$ when M is a smooth even-dimensional manifold.

Braid groups of surfaces and their lower algebraic K-theory

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I will review the theory of braid groups for surfaces, some of their properties and will concentrate on the braid groups for the sphere and the proyective plane. I will also explain how the geometry of the braid groups determine the lower algebraic K theory of their integral group rings.

Equivariant Chern numbers and the number of fixed points for unitary torus manifolds

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Let M^{2n} be a unitary torus $(2n)$-manifold, i.e., a $(2n)$-dimensional oriented stable complex connected closed T^n-manifold having a nonempty fixed set. We show that M bounds equivariantly if and only if the equivariant Chern numbers $\langle (c_1^{T^n})^i (c_2^{T^n})^j, [M]\rangle = 0$ for all $i, j \in \mathbb{N}$, where $c_l^{T^n}$ denotes the lth equivariant Chern class of M. As a consequence, we also show that if M does not bound equivariantly then the number of fixed points is at least $\lceil \frac{n}{2} \rceil + 1$, where $\lceil \frac{n}{2} \rceil$ denotes the minimal integer no less than $\frac{n}{2}$.

Virtual orbifold cohomology

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In this talk I will introduce Virtual Orbifold Cohomology as an open-closed nearly orbifold TQFT and explain its relation to Chen-Ruan cohomology and to String Topology. This is joint work with Ana Gonzalez, Bernardo Uribe and Carlos Segovia.

Cohomology fo symmetric and alternating groups

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The homology and cohomology of symmetric groups has a long history. Recently we have found that a Hopf ring structure first discovered by Strickland and Turner helps to give a description of the mod-two ring structure which gives rise to a new additive basis with explicit multiplication rules, as well as clarifies and illuminates previous approaches. I will describe this structure, and then address other coefficients for symmetric groups as well as the mod-two cohomology of alternating groups.

Classification of complex projective towers up to dimension 8 and cohomological rigidity

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A complex projective tower or simply a $\mathbb{C}P$-tower is an iterated complex projective fibrations starting from a point. In this paper we classify all 6-dimensional $\mathbb{C}P$-towers up to diffeomorphism, and as a consequence, we show that all such manifolds are cohomologically rigid, i.e., they are completely determined up to diffeomorphism by their cohomology rings. We also show that cohomological rigidity is not valid for 8-dimensional $\mathbb{C}P$-towers by classifying some $\mathbb{C}P^1$-fibrations over $\mathbb{C}P^3$ up to diffeomorphism. As a corollary we show that such $\mathbb{C}P$-towers are diffeomorphic if they are homotopy equivalent.

Homology of Hurwitz spaces and the Cohen-Lenstra heuristics

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We will examine Hurwitz moduli spaces of branched covers of Riemann surfaces, and study their stable homology (as the number of branch points tends to infinity). The results may be used to prove a function field analogue of the Cohen-Lenstra heuristics on the distribution of class groups of imaginary quadratic number fields. The main tools are a homological stability theorem for these spaces, as well as an identification of their limit as a space of functions into a target which supports a certain "universal" branched cover.

On simplicial resolutions of framed links

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In this paper, we investigate the simplicial groups obtained from the link groups of naive cablings on any given framed link. Our main result states that the resulting simplicial groups have the homotopy type of the loop space of a wedge of 3-spheres. This gives simplicial group models for some loop spaces using link groups.

Joint with Fengchun Lei and Fengling Li

Rigidity of matrix groups

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Let R be a general ring and $E_n(R)$ the subgroup of general linear group generated by elementary matrices. Is there a nontrivial group homomorphism $E_{n+1}(R) \to E_n(R)$? I will talk about how to consider such a problem by group actions on CAT(0) spaces, spheres and acyclic manifolds.

Special Session 4
Applications of Harmonic Maps and Submanifold Theory

The Liouville property for pseudoharmonic maps with finite Dirichlet energy

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In this talk, we first derive the CR Bochner formula and the CR Kato's inequality for pseudoharmonic maps. Secondly, by applying the CR Bochner formula and the CR Kato's inequality we are able to prove the Liouville property for pseudoharmonic maps with finite Dirichlet energy in a complete $(2n+1)$-pseudohermitian manifold. This is served as an analogue to the Liouville theorem for harmonic maps in Riemannian Geometry.

On the Toda systems of VHS type

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We consider the Toda systems of VHS type with singular sources and provide a criterion for the existence of solutions with prescribed asymptotic behaviour near singularities. We also prove the uniqueness of solution. Our approach uses Simpson's theory of constructing Higgs-Hermitian-Yang-Mills metrics from stability.

A rigidity theorem for self-shrinkers of the mean curvature flow

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In this talk, by using a Simons' type inequality and an improved Sobolev inequality of submanifolds, we can prove a global rigidity theorem for self-shrinkers as hypersurfaces whose mean curvature and total curvature satisfy some appropriate conditions.

Geometry of Lagrangian submanifolds related to isoparametric hypersurfaces

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In this talk I shall provide a survey of my recent works and their environs on differential geometry of Lagrangian submanifolds in specific Kähler manifolds, such as complex projective spaces, complex space forms, Hermitian symmetric spaces and so on. I shall emphasis on the relationship between certain minimal Lagrangian submanifold in complex hyperquadrics and isoparametric hypersurfaces in spheres. This talk is mainly based on my joint work with Associate Professor Hui Ma (Tsinghua University, Beijing).

Definite affine spheres by the DPW method

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We will first clarify the loop group formulations for both hyperbolic and elliptic proper definite affine spheres in $\mathbb{R}^3$, relating them to primitive harmonic maps from a Riemann surface to 6-symmetric spaces $\mathrm{SL}_3(\mathbb{R})/\mathrm{SO}_2(\mathbb{R})$. Then we will apply Dorfmeister-Pedit-Wu's method to give Weierstrass type representation of such surfaces using holomorphic/meromorphic potentials. New examples and pictures constructed from special type of potentials will be presented in the end, including equivariant ones. This is a joint work with Professor Josef Dorfmeister.

Willmore surfaces by using geometric methods and loop group theory

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In this talk we will first introduce the notion of adjoint transforms of Willmore surfaces in S^n. The relations between adjoint transforms of Willmore surfaces and the other harmonic maps associated with Willmore surfaced independently by Hélein and Xiang Ma, are also discussed briefly. Applying the DPW methods and the theory of Burstall-Guest for harmonic maps of finite uniton, we obtained some descriptions of adjoint transforms and Hélein-Ma's harmonic maps as well as some interesting examples of Willmore surfaces together with their adjoint surfaces. Some of these results is an adjoint work with Prof. Josef Dorfmeister.

Special Session 5
Combinatorics and Discrete Mathematics

On tight relative t-designs

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The purpose of design theory is to study good subsets which approximate the whole space. This is the case for spherical t-designs (i.e. finite subsets of spheres) or for combinatorial t-designs, here a combinatorial t-(v, k, λ) design means a good subset which approximates the space of all k element subsets of a v set. Euclidean t-designs are certain generalizations of spherical designs. Relative t-designs (defined by Delsarte) are certain generalizations of combinatorial t-designs. Note that t-designs and relative t-designs are defined for any Q-polynomial association schemes. In particular, for the binary Hamming association scheme $H(n, 2)$ (i.e. the n-dimensional vector space over the binary field) the concept of relative t-design is equivalent to the concept called regular t-wise balanced design in combinatorial design theory. Our main purpose is to study (and classify if possible) the objects called tight design, i.e. those t-designs or relative t-designs whose cardinalities attain the natural lower bounds called Fisher type lower bounds, in various situations. Usually, these tight designs are expected to have good algebraic structures, such as association schemes, or coherent configurations.

It is known that there are close similarities between "theory of spherical t-designs vs. theory of Euclidean t-designs" and "theory of combinatorial t-designs vs. theory of relative t-designs in binary Hamming schemes." The former theories have been studied more extensively than the latter ones, since spherical harmonics is more transparent than the theory of harmonic analysis on finite homogeneous spaces, i.e. on certain association schemes. We will discuss how much we can imitate the former theories to get similar results in the latter case. For example, we obtain the following explicit results on tight relative t-designs in binary Hamming association schemes.

(i) For tight relative $2e$-designs in binary Hamming association schemes, the weight function must be constant on each shell.

(ii) For tight relative 2-designs on two shells in binary Hamming association schemes $H(n, 2)$, we can have the structure of coherent configurations.

(iii) We can classify tight relative 2-designs on two shells in binary Hamming association schemes $H(n, 2)$ for small n, say $n \leq 30$.

We will also study more general results for more general association schemes. The contents of this talk are based on the following two joint papers with other authors.

(1) Eiichi Bannai, Etsuko Bannai, Sho Suda and Hajime Tanaka: On relative t-designs in polynomial association schemes, arXiv:1303.7163

(2) Eiichi Bannai, Etsuko Bannai and Hideo Bannai: On the existence of tight relative 2-designs on binary Hamming association schemes, arXiv:1304.5760

On the efficient solution of some packing and covering problems in graphs

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Let G be a finite undirected and simple graph whose set of edges represents the "conflicts" of some objects. A *packing problem* asks for a largest set of vertices which are pairwise conflict-free, and a *covering problem* asks for a smallest set of vertices which "cover" some objects. Typical examples are Maximum Independent Set as packing problem and Minimum Vertex Cover as covering problem, however, there are many other variants such as domination problems. In many cases, the problems are also weighted, and sometimes covering and packing conditions are combined. It is well known that such problems are typically NP-complete, and most of them are hard to approximate.

We look at some examples such as Efficient Domination, Efficient Edge Domination (which is sometimes called Dominating Induced Matching), and Maximum Induced Matching and restrict them to inputs from structured graph classes. If the graph class has certain kinds of tree structure, most of the problems become efficiently solvable. This holds for tree decomposition by clique separators and modular decomposition into "simple" parts as well as width restrictions such as treewidth and clique-width. Moreover, there are some useful closure properties of squares of graphs and line graphs.

From metrics to diversities

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A *diversity* is a generalisation of metric spaces to beyond pairwise comparisons. Formally, it is a pair (X, δ) where X is a set and δ is a non-negative function defined on finite subsets of X satisfying the two axioms

1. $\delta(A) = 0$ if and only if $|A| \leq 1$;
2. $\delta(A \cup C) \leq \delta(A \cup B) + \delta(B \cup C)$ whenever $B \neq \emptyset$.

Note that δ restricted to pairs gives a metric. Examples of diversities include the diameter, the mean width, the length of the minimum tour, and the length of an optimal Steiner tree. Diversities were introduced in a recent paper of Bryant and Tupper, and generate a rich theory which we are only just beginning to explore. We survey some of the main results and then speculate wildly on applications and future developments.

Boxicity and cubicity of graphs

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A graph is said to have a d-dimensional box representation (respectively cube representation-we consider d-dimensional cubes of unit volume) if the vertices of G can be assigned axis parallel d-dimensional boxes (resp. cubes) in such a way that two vertices are adjacent if and only i the corresponding boxes (resp. cubes) intersect. The smallest non-negative integer d for which this is possible, is the boxicity (resp. cubicity) of the graph G. In this talk we will present an overview of the results we obtained on boxicity and cubicity of graphs over the last few years. For example, we will discuss the relation of boxicity and cubicity with the width parameters such as treewidth and bandwidth, the connection between boxicity and the partial order dimension and upper bounds for cubicity in terms of boxicity, and some interesting results regarding the boxicity and cubicity of certain special classes of graphs.

Parallelohedra: from Minkowski and Voronoi to the present day

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A parallelohedron is a convex polyhedron which tiles the Euclidean space by parallel copies in face-to face way. The concept of parallelohedron was introduced by E. Fedorov, the Russian crystallographer. He found all the five combinatorial types of 3-dimensional parallelohedra which are of great importance in crystallography. High-dimensional parallelohedra have many applications in geometry of numbers and some other other fields of mathematics. In addition, high-dimensional parallelohedra present an extremely interesting class of polyhedra in itself. An obvious example of a parallelohedron of any dimension is the parallelepiped. Much more interesting type of a parallelohedron is presented by the permutahedron of any dimension.
First fundamental theorems on parallelohedra were been found by H. Minkowski. G. Voronoi developed the theory of a special type of a parallelohedra that are Voronoi regions for lattices and now called the Voronoi parallelohedra. Voronoi showed their importance for the study of arbitrary parallelohedra. Further important steps in the field have been done by B. Delone, A. Alexandrov, O. Zhitomirski, B. Venkov, S.Ryshkov, P. McMullen, R. Erdahl, and others.
At the same time, despite the considerable efforts, the central problem - a proof of the Voronoi conjecture on the affine equivalence of an arbitrary parallelohedron to some Voronoi parallelohedron - remains unresolved. In the talk we are going to present an overview of classical results of the theory of parallelohedra as well as some recent results obtained by the author and his students A. Garber, A. Magazinov, and A.Gavrilyuk.

What is and to which end does one study phylogenetic combinatorics?

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When Friedrich Schiller gave his inaugural lecture as a Professor of History in Jena on May 26, 1789, he entitled it "Was heißt und zu welchem Ende studiert man Universalgeschichte?", that is, "What is and to which end does one study world history?". In this lecture, he distinguished two kinds of scholars, the **bread scholar** who just works for the money and with neither interest nor ability to recognize the "big picture" (Gesamtzusammenhänge) and who is frightened of any innovation *because it shatters the old traditional system that he so laboriously adopted*, and the **philosophical mind** whose *efforts are directed toward the perfection of his knowledge*, who is delighted by *new discoveries in the sphere of his activities, who has always loved the truth more than his system, and who will gladly be the first to abandon to re-establish a more perfect view.*
Similarly, one studies phylogenetic combinatorics to elucidate the rules and patterns of species evolution and population genetics *under the influence of the four main evolutionary processes: natural selection, genetic drift, mutation and gene flow* (Wikipedia) and needs to combine modern biological knowledge and insight with innovative mathematical conceptualization, modelling and algorithm design supported by computer-science based IT architectures and strategies.
In the lecture, I will particularly stress the importance of phylogenetic networks and the mathematical concepts that support phylogenetic-network construction, the **tight-span** concept, the method of **split-decomposition**, and the **quartet-analysis** based approach.

Slim systems of binary phylogenetic trees

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A phylogenetic tree is a tree where the leaves are labeled by taxonomic units, e.g. species. Such trees are used in systematic biology to visualize the evolutionary history of those taxa. A common problem in phylogenetics is that we observe several small trees with overlapping but non-identical taxa sets and we would like to construct a tree on the union of the taxa that displays all the information of the input trees. In general, it is NP-complete to decide whether such a "supertree" exists and whether it is unique. On the other hand, there is a lower bound on the total number of interior edges in order to have a unique supertree. If this bound is exactly attained, then the uniqueness question can be decided in polynomial time and the supertree can be constructed by gluing them together in a pairwise fashion. This surprising result was first established in the PhD thesis by Sebastian Böcker in 1999 and was referred to as "one of the most mysterious and apparently difficult results in phylogeny". In my talk I will sketch a simplified proof that I published in 2012 and some further improvement made by Andreas Dress.

New trends for graph searches

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Since the 1950s, search, a mechanism for visiting the vertices and edges of a graph, has been a fundamental technique in the design of graph algorithms. In this talk I will survey some new results of computation of graph parameters using graph searches, but also how to discover graph structure using a series of graph searches. In fact using the seminal work [2], many graph searches can be characterized by conditions on the visiting order of the vertices. These conditions are very useful for algorithm design.
First I will describe how to evaluate the diameter of a graph using only 4 successive BFS (Breadth First searches). This heuristic is very acurate and can be applied on huge graphs. Furthermore it can be completed by an exact algorithm which seems to be very efficient (much more that its worst case complexity indicates).
Then I will focuse on cocomparability graphs showing that first LDFS (Lexicographic Depth First Search) can be used to compute a minimum path cover. A comparability graph is a graph that admits a transitive orientation, and a cocomparability graph is simply the complement of a comparability graph. Both classes comparability and cocomparability graphs are well studied subclasses of perfect graphs [3]. Cocomparability graphs generalize interval graphs, and we generalize for cocomparability graphs some algorithmic results already obtained for interval graphs [1].
I will finish by describing some fixed point properties of graph search acting on a cocomparability graph, describing many open problems.

[1] Corneil D.G., Dalton B., Habib M.: *LDFS-based certifying algorithm for the Minimum Path Cover problem on cocomparability graphs*, to appear SIAM J. Comput.
[2] Corneil D.G., Krueger R.: *A Unified View of Graph Searching*, SIAM J. Discrete Math. 22(4): 1259-1276 (2008).
[3] M. C. Golumbic *Algorithmic Graph Theory and Perfect Graphs*, Volume 57, Second Edition, Annals of Discrete Mathematics, 2004.

Enumeration in graph classes

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Enumerating, counting, and determining the maximum number of various objects in graphs have long been established as important areas within graph theory and graph algorithms. As the number of enumerated objects is very often exponential in the size of the input graph, enumeration algorithms fall into two categories depending on their running time: those whose running time is measured in the size of the input, and those whose running time is measured in the size of the output. Based on this, we concentrate on the following two types of algorithms.

1. Exact exponential time algorithms. The design of these algorithms is mainly based on recursive branching. The running time is a function of the size of the input graph, and very often it also gives an upper bound on the number of enumerated objects any graph can have.

2. Output polynomial algorithms. The running time of these algorithms is polynomial in the number of the enumerated objects that the input graph actually contains. Some of these algorithms have even better running times in form of incremental polynomial or polynomial delay, depending on the time the algorithm spends between each consecutive object that is output.

The methods for designing the two types of algorithms are usually quite different. Common to both approaches is that efforts have traditionally mainly been concentrated on arbitray graphs, whereas graphs with particular structure have largely been left unattended. In this talk we look at enumeration of objects in graphs with special structure. In particular, we focus on enumerating minimal dominating sets in various graph classes.

Algorithms of type 1: The number of minimal dominating sets that any graph on n vertices can have is known to be at most 1.7159^n. This upper bound might not be tight, since no examples of graphs with 1.5705^n or more minimal dominating sets are known. For several classes of graphs, like chordal, split, and proper interval graphs, we substantially improve the upper bound on the number of minimal dominating sets. At the same time, we give algorithms for enumerating all minimal dominating sets, where the running time of each algorithm is within a polynomial factor of the proved upper bound for the graph class in question. In some cases, we provide examples of graphs containing the maximum possible number of minimal dominating sets for graphs in that class, thereby showing the corresponding upper bounds to be tight.

Algorithms of type 2: Enumeration of minimal dominating sets in graphs has very recently been shown to be equivalent to enumeration of minimal transversals in hypergraphs. The question whether the minimal transversals of a hypergraph can be enumerated in output polynomial time is a fundamental and challenging question; it has been open for several decades and has triggered extensive research. We show that all minimal dominating sets of a line graph can be generated in incremental polynomial, and consequently output polynomial, time. We are able to improve the delay further on line graphs of bipartite graphs. Finally we show that our method is also efficient on graphs of large girth, resulting in an incremental polynomial time algorithm to enumerate the minimal dominating sets of graphs of girth at least 7.

The presentation is based on joint works with following co-authors: Jean-Francois Couturier, Petr Golovach, Pim van 't Hof, Dieter Kratsch, and Yngve Villanger.

Matrix partitions

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I will survey recent work on vertex partitions of graphs with certain internal and certain external constraints. (These constraints are conveniently encoded in a matrix.) Many well studied examples, especially from the study of perfect graphs, fit into this model. The results discussed will include both algorithms and characterizations. Many open problem will be posed.

The lexicographic method

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Lexicographic techniques have been identified as an important tool in the design of graph algorithms. In this talk I will give a short survey of how the techniques are used for solving graph problems such as recognitions, orientations, representations, and homomorphisms.

On m-walk-regular graphs, a generalization of distance-regular graphs

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In this talk I will discuss m-walk-regular graphs. These graphs were introduced by Fiol and Garriga in 1999 as a generalization of distance-regular graphs. 0-Walk-regular graphs were earlier introduced by Godsil and McKay as walk-regular graphs. They showed that a graph G is walk-regular if and only if the spectrum of G where I delete a vertex x does not depend on the vertex x.

Our main motivation to study m-walk-regular graphs is to understand the difference between m-walk-regular graphs and distance-regular graphs. We will show that many results on distance-regular graphs can be generalized to 2-walk-regular graphs. We also give many examples of m-walk-regular graphs which are not distance-regular. But we also show that some results on distance-regular graphs are not true for 2-walk-regular graphs.

Geometric representations of graphs

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Geometric representations of graphs are intensively studied both for their practical motivation and interesting combinatorial properties. We will survey recent development in this area, including recent results on coloring geometric intersection graphs and computational complexity of extending partial geometric representations.

The practice of graph isomorphism

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We are concerned with the practical aspects of computing the automorphism groups of graphs, and determining canonical labellings of graphs. The speaker's program `nauty` has been around since 1976, though it wasn't called that until about 1983. Until a few years ago, there wasn't very much competition, but then came `saucy`, `Bliss`, `conauto`, and some other programs that could outperform `nauty` in many cases.

Our aim in the talk is to describe our response to the challenge. In particular, `nauty` is now bundled with a highly innovative program called `Traces`. We contend that the present edition of `Traces` is now the performance champion. The talk will describe how these programs work and give a comparison between them.

This is joint work with Adolfo Piperno (University of Rome).

Structural limits in logical and analytic context

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We survey recent development of limits of graphs (and other structures) in the unifying context of model theory. Particularly, this leads to the analysis of limits of sparse graphs (with unbounded degrees). This is joint work with Patrice Ossona de Mendez (EHESS, Paris).

Unavoidable vertex-minors in large prime graphs

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A graph is *prime* (with respect to the split decomposition) if its vertex set does not admit a partition (A, B) (called a *split*) with $|A|, |B| \geq 2$ such that if a pair of vertices in A have neighbors in B, then they have the same set of neighbors in B. We prove that for each t, every sufficiently large prime graph must contain a vertex-minor isomorphic to either a cycle of length t or a graph consisting of two vertices joined by t 3-edge paths and no other edges. This is a joint work with O-joung Kwon (KAIST).

The structure of a typical H-free graph

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We discuss the structure of a typical graph which does not contain H as an induced subgraph and prove a weakening of the Erdos-Hajnal conjecture. The talk presents joint work with F. Havet, R. Kang, P. Keevash, M. Loebl, C. McDiarmid, J. Noel, A. Scott, and A. Thomason.

Hamiltonian cycles in prisms

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The prism over a graph G is the Cartesian product of G with K_2. My interest in prisms began in 1973 when I tried to tackle Dave Barnette's conjecture (1970) that all simple 4-polytopes are Hamiltonian (still open). Subsequently, we merged the study of Hamiltonian cycles in prisms with other refinements of Hamiltonian cycles. We observed that if G has a Hamiltonian prism then G has a spanning closed 2-walk but the opposite is not true, that is having a Hamiltonian prism is "closer" to being Hamiltonian than having a spanning, closed 2-walk. This observation created many opportunities to study various classical problems on Hamiltonicity of graphs.

In this talk I will discuss some results on prism Hamiltonicity, further refinements of Hamiltonicity and related open problems.

On the computation of the Radon number in some graph convexities

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A *graph convexity* is a pair $(G, \mathcal{C})$, where G is a finite graph with vertex $V(G)$ and $\mathcal{C}$ a family of subsets of $V(G)$ satisfying $\emptyset, V(G) \in \mathcal{C}$ and being closed under intersections. The sets $C \in \mathcal{C}$ are called *convex sets.* The most common graph convexities are those whose convex sets are defined through special paths of the graph. Among them the most prominent are the *geodesic convexity*, where $\mathcal{C}$ is closed under taking shortest paths, the *monophonic convexity*, where $\mathcal{C}$ is closed under induced subgraphs and the P_3 convexity, whose convex sets are closed under pairs of common neighbors. In special, the latter is closely related to some well studied graph processes, as percolation and conversion processes. We examine some common parameters of graph convexities, as the *geodetic number, convexity number, hull number, Helly number, Carathéodory number and Radon number.* In particular, we describe complexity results related to the computation of the Radon number. These include hardness results, polynomial-time algorithms and bounds.

A class of periodic continued fractions and factorization in modular group

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In this talk we introduce some properties of periodic continued fractions of the form

$$\underbrace{\frac{-1}{b_1}+\frac{-1}{b_2}+\cdots+\frac{-1}{b_n}}_{n}+\underbrace{\frac{-1}{b_1}+\frac{-1}{b_2}+\cdots+\frac{-1}{b_n}}_{n}+\cdots, \qquad (1)$$

where b_k are (positive) integers. Such continued fractions are called periodic negative-regular continued fraction. By Tietze's theorem [1], the fraction (1) converges to an irrational number if $|b_k| \geqslant 2$ (except for the case $|b_k| = 2$ for all k).

We have proved that without the requirement $|b_k| \geqslant 2$ the fraction (1) may converge to rational numbers or diverge. This is the difference between negative-regular continued fractions and classical regular continued fractions. The last one always converge to irrational numbers.

Several algorithms for construction of periods $\{b_1, \ldots, b_n\}$ of periodic negative-regular continued fractions converging to rational numbers are given. The periods of a given length can be obtained by Fermat's infinite descent method applied to some Diophantine equations. An explicit simple formula for the minimal period for x is presented. A construction using the Calkin-Wilf tree and Stern's diatomic series is described. Arbitrary primitive periods are in one-to-one correspondence with elements of the modular group Γ. Explicit formulas converting products of the standard generators S and ST in Γ into primitive periods are obtained. The periods of elliptic elements of Γ are completely described. This description results in a parametric formula for primitive periods of rational numbers. A periodic negative-regular continued fraction diverges if and only if either its period or its double or its triple represents the identity in Γ.

[1] H. Tietze, "Uber Kriterien für Konvergenz und Irrationalität unendlicher Ketenbrüche", Math. Ann. **70** (1911).

The graph isomorphism problem on geometric graphs

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The graph isomorphism (GI) problem asks whether two given graphs are isomorphic or not. That is, it asks whether there exists a one-to-one mapping between two given graphs. The GI problem is quite basic and simple, however, it's time complexity is a long standing open problem. The problem is clearly in NP, but it is not known to be NP-complete or not. The GI problem is one of candidates between the classes NP and P. The problem has four aspects from the viewpoints of theoretical computer science. (1) What the computational complexity class that captures the GI problem? (2) How fast can we solve the problem (in exponential time)? (3) What the graph classes such that the GI problem is still as hard as general graphs? (4) What the graph classes such that the GI problem can be solved in polynomial time. In this talk, I focus on (3) and (4). If we can clarify this gap, it indicates the essential difficulty of the GI problem. Last few decades, many graph classes are proposed and investigated. Among them, we focus on some graph classes that have geometric characterization. Typical examples are interval graphs, that are intersection graphs of intervals, and chordal graphs, that are intersection graphs of subtrees of a tree. The GI problem can be solved in linear time for interval graphs, while the GI problem for chordal graphs is as hard as general graphs. Some basic techniques to show these results are presented, and I present some graph classes such that the complexity of the GI problem are not known.

On-line list colouring of graphs

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The on-line choice number of a graph is a variation of the choice number defined through a two person game. Given a finite graph G and a mapping $f : V(G) \to N$, two players, the Lister and the Painter, play the *on-line* (G, f)*-list colouring game* defined as follows: In the i-th step, the Lister presents a non-empty subset V_i of $V(G) \setminus \cup_{j=1}^{i-1} X_j$, and the Painter chooses an independent set X_i contained in V_i. If $v \in V_i$, then we say colour i is a permissible colour of vertex v. If $v \in X_i$, then we say v is coloured by colour i. If at the end of a certain step, a vertex v is given $f(v)$ permissible colours but remains uncoloured, then the game ends and the Lister wins the game. Otherwise, at some step, all vertices are coloured, the game ends and the Painter wins the game. We say G is *on-line* f*-choosable* if the Painter has a winning strategy in the on-line (G, f)-list colouring game, and we say G is *on-line* k*-choosable* if G is on-line f-choosable for the constant function $f \equiv k$. The *on-line choice number* of G, denoted by $\chi_P(G)$, is the minimum k for which G is on-line k-choosable. It follows from the definition that for any graph $\chi_P(G) \geq ch(G)$, where $ch(G)$ is the choice number of G. There are graphs G for which $\chi_P(G)$ is strictly larger than $ch(G)$. In particular, there are graphs G with $|V(G)| = 2\chi(G) + 1$ with $\chi_P(G) > \chi(G)$, in contrast to a recently confirmed conjecture of Ohba that every such graph has $\chi(G) = ch(G)$. It was conjectured by Huang, Wong and Zhu that every graph G with $|V(G)| \leq 2\chi(G)$ has $\chi_P(G) = \chi(G)$. This talk presents some progress on the study of the conjecture, and some results on the upper bounds for the on-line choice number of classes of graphs.

Special Session 6
Geometric Analysis

Convergence of scalar-flat metrics on manifolds with boundary under the Yamabe flow

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In this talk I will discuss a convergence theorem for a Yamabe-type flow on manifolds with boundary. This is a flow that evolves conformal scalar-flat metrics according to equations envolving the boundary mean curvature. Convergence to a scalar-flat metric with constant boundary mean curvature is established assuming either a positive mass theorem or a genetric condition.

Curvature behavior at singularity time of Ricci flow

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In this talk, we will first survey some known result about curvature behavior at the first finite-singularity time under the Ricci flow. Then we will discuss some recent development in this direction and their applications.

Complete pseudohermitian manifolds with positive spectrum

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In this paper, we study complete noncompact pseudohermitian manifolds with positive spectrum of the sub-Laplacian. We proved splitting- type theorems for a class of complete noncompact pseudohermitian manifolds with vanishing torsion whose spectrum of the sub-Laplacian has an optimal positive lower bound. These can be viewed as the CR analogue of theorems of Li-Wang and the equality case of a theorem of Cheng.

Affine cones over smooth del Pezzo surfaces

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We answer negatively the old question of Misha Zaidenberg and Hubert Flenner by proving that affine cones over smooth cubic surfaces do not admit non-trivial actions of the additive group. Our proof uses the alpha-functions of smooth del Pezzo surfaces and classical birational constructions that go back to Manin and Serge.

Symplectic mean curvature flow in $\mathbb{C}P^2$

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I will give a talk about the symplectic mean curvature flow in $\mathbb{C}P^2$. Under some pinching conditions, the symplectic mean curvature flow exists for long time and converges to a holomorphic curve.

Ricci flow and 4-manifolds with positive isotropic curvature

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We'll survey the work by Hamilton, Chen, Tang, Zhu and the speaker on the classification of complete 4-manifolds (or orbifolds) with positive isotropic curvature. The main tool used here is the Hamilton-Perelman theory on Ricci flow with surgery. When we consider noncompact manifolds or orbifolds we need to adapt the original Hamilton-Perelman theory. We'll indicate the necessary modifications in these cases.

Convergence of Calabi flow with small initial data

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We will discuss the long time existence and convergence of the Calabi flow under some small initial conditions without assuming the existence of constant scalar curvature Kähler metrics. This is joint work with Kai Zheng.

K-stability of Fano varieties and Alpha invariant

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The K-stability is first defined by Tian and later generalized by Donaldson formally as a positivity of *generalized Futaki invariants*. This talk will focus on the case of Fano varieties.

Thanks to the recent celebrated works of the proof of existence of Kähler-Einstein metrics on K-stable Fano manifolds due to Chen-Donaldson-Sun and Tian, the K-stability has been finally proved to be equivalent to the existence of Kähler-Einstein metrics i.e. we can in principle study the existence problem algebro-geometrically. However it is in general hard, at the moment, to test K-stability.

The speaker will review the basic structure of the generalized Futaki invariants from algebro-geometric viewpoint and gives relation with (the Minimal model program-based) birational geometry, in particular introducing the notion of "destabilizing subschemes" after the wake of Ross-Thomas. This analysis in particular will give a proof of K-stability of Fano n-fold X with $\alpha(X) > \frac{n}{n+1}$ which corresponds to the theorem of Tian in 80s where the alpha invariant $\alpha(X)$ was introduced. This talk will be based on a joint work with Yuji Sano.

α-functions of smooth del Pezzo surfaces

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We define α-functions of Fano varieties by considering the α-invariants of G. Tian locally. We demonstrate how to obtain the α-functions of smooth del Pezzo surfaces. In addition, their applications are briefly introduced.

Bergman kernel of a polarized Kähler ALE manifold

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I shall report some recent joint work with Claudio Arezzo and Alberto Della Vedova on the Bergman kernel of Kähler ALE manifolds.

The first eigenvalue of minimal submanifolds in an unit sphere

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We will talk about the first eigenvalue of a minimal isoparametric hypersurface in a unit spheres, as well as that of their focal submanifolds. For the special case, we verify Yau's conjecture.

The regularity of limit space

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This is a joint work with Tian. We study the structure of the limit space of a sequence of almost Einstein manifolds, which are generalizations of Einstein manifolds.Roughly speaking, such manifolds are the initial manifolds of some normalized Ricci flows whose scalar curvatures are almost constants over space-time in the L^1-sense, Ricci curvatures are bounded from below at the initial time. Under the non-collapsed condition, we show that the limit space of a sequence of almost Einstein manifolds has most properties which is known for the limit space of Einstein manifolds. As applications, we can apply our structure results to study the properties of Kähler manifolds.

The limit of the Yang-Mills-Higgs flow on semi-stable Higgs bundles

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In this talk, we consider the gradient flow of the Yang-Mills-Higgs functional for Higgs pairs on a Hermitian vector bundle (E, H_0) over a compact Kähler manifold (M, ω). We study the asymptotic behavior of the Yang-Mills-Higgs flow for Higgs pairs at infinity, and show that the limiting Higgs sheaf is isomorphic to the double dual of the graded Higgs sheaves associated to the Harder-Narasimhan-Seshadri filtration of the initial Higgs bundle.

Ricci curvature in Kahler-Ricci flow

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Ricci curvature is a geometric quantity naturally related to the behaviour of Ricci flow. In this talk, we discuss some recent results on the relations between the various bounds of Ricci curvature and the Kähler-Ricci flow existing for either finite or infinite time.

A class of Weingarten curvature measures

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In this talk, we study the weak continuity of k-curvature measures of locally bounded, upper semicontinous functions which are subharmonic with respect to k-curvature operators. The the proof uses the monotonicity integral inequality. This is a joint work with Qiuyi Dai and Xu-jia Wang.

Special Session 7
Geometric Aspects of Semilinear Elliptic Equations: Recent Advances & Future Perspectives

Regularization of point vortex solution for Euler equation

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In this talk the speaker will talk about the regularization of point vortex solution for Euler equation of 2 dimension. The existence of point vortex solutions is closely related to the so called Kirchhoff Routh function. The critical points of Kirchhoff Routh function can deduce a steady point vortex solution. For a given critical point of Kirchhoff Routh function, can one establish the existence of smooth steady solutions approximating the point vortex solution deduced by the point? He will talk about the previous study concerning this respect. A newly obtained results by the speaker and his collaborators, Liu Zhong Yuan and Wei Juncheng, will be introduced.

Nonlocal minimal surfaces

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Caffarelli, Roquejoffre and Savin (2010) introduced a notion of nonlocal minimal surface, which is a boundary of a set that is minimal with respect to an s-perimeter functional, where $0 < s < 1$. It is natural to consider critical points of the s-perimeter, which we call s-minimal surfaces. Up to now there are very few examples of such sets. Starting from the property that as $s \to 1$, the s-minimal equation approaches the classical minimal surface equation, we construct new examples of s-minimal surfaces for s close to 1.
This is joint work with Manuel del Pino (Universidad de Chile) and Juncheng Wei (Chinese University Of Hong Kong and University of British Columbia).

Solutions for a semilinear elliptic equation in dimension two with supercritical growth

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We consider the problem

$$\begin{aligned} -\Delta u &= \lambda u e^{u^p}, \quad u > 0, \quad \text{in} \quad \Omega, \\ u &= 0 \quad \text{on} \quad \partial\Omega, \end{aligned}$$

where $\Omega \subset \mathbb{R}^2$ and $p > 2$. Let λ_1 be the first eigenvalue of the Laplacian. For each $\lambda \in (0, \lambda_1)$, we prove the existence of solutions for p sufficiently close to 2. In the case of Ω a ball, we also describe numerically the bifurcation diagram (λ, u) for $p > 2$.

On the entire radial solutions arising in Chern-Simons equations

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In this paper, we study the the entire radial solutions of $(*)$:

$$\begin{aligned} \Delta u = &-(1+a)(e^u - (1+a)e^{2u} + ae^{u+v}) \\ &+ a(e^v - (1+b)e^{2v} + be^{u+v}) \\ &+ 4\pi N_1 \delta_0 \end{aligned}$$

$$\begin{aligned} \Delta v = &-(1+b)(e^v - (1+b)e^{2v} + be^{u+v}) \\ &+ b(e^u - (1+a)e^{2u} + ae^{u+v}) \\ &+ 4\pi N_2 \delta_0. \end{aligned}$$

Here, $a > 0$, $b > 0$, $N_1 \geq 0$, and $N_2 \geq 0$. This system is motivated by studying the equations of relativistic non-Abelian Chern-Simons model proposed by by Kao-Lee and Dunne and Gudnason model of $\mathcal{N}$ =2 supersymmetric Yang-Mills-Cherns-Simons-Higgs theory. Understanding the structure of entire radial solutions is one of fundamental issues for the system of nonlinear equations. Under certain technical conditions for a and b, we prove that any entire radial solutions of $(*)$ must be one of topological, non-topological and mixed type solutions, and completely classify the asymptotic behaviors at infinity of these solutions. As an application of this classification, we prove that the two components u and v have intersection at most finite times.

Existence and non-existence of positive solutions on the Hardy-Littlewood-Sobolev type systems

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In this presentation, we provide some existence, nonexistence, and classification of positive solutions for Hardy-Littlewood-Sobolev type systems. In deriving these results, some useful methods are created. We will briefly introduce some of the involved methods.

Singly periodic solutions of the Allen-Cahn equation and the Toda lattice

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We study the Allen-Cahn equation in the plane:

$$-\Delta u = u - u^3, \ \ in \ \mathbf{R}^2.$$

Of interest are bounded entire solutions whose behavior at infinity is in some sense simple. Examples are those with finite Morse index, which have been extensively studied in the past. Here we will construct solutions which are periodic in one direction in the plane, but are not doubly periodic. The core of the construction is the one-soliton solution of the Toda lattice, which is a classical integrable system. This is joint work with M. Kowalczyk, F. Pacard and J. Wei.

Critical Trudinger Moser equation in $\mathbb{R}^2$

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We review some new results on construction of single and multiple bubbling solutions for variational problems leading to semilinear equations with nonlinearities of Trudinger Moser type.

Multi-dimensional traveling fronts in bistable reaction-diffusion equations

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Multi-dimensional traveling fronts have been studied by mathematicians for bistable reaction-diffusion equations in the whole space. Especially, cylindrically symmetric traveling fronts have been studied by Hamel, Monneau and Roquejoffre (2005). We study traveling fronts of cylindrically non-symmetric shapes in bistable reaction-diffusion equations.

Existence and regularity of mean curvature flow with transport term

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Given a compact C^1 hypersurface in $\mathbf{R}^n$ $(n \geq 2)$ and a vector field $u : \mathbf{R}^n \times [0,\infty) \to \mathbf{R}^n$ which belongs to $L^q_{loc}([0,\infty); W^{1,p}_{loc}(\mathbf{R}^n))$, $p > \frac{n}{2} \cdot \frac{q}{q-1}$, $p \geq 2$, $q > 2$, we prove some existence result for evolving hypersurfaces whose velocity is given by its mean curvature plus u. For the existence, we take the singular perturbation limit of the Allen-Cahn equation with additional transport term. The regularity issue is also discussed. This is a joint work with K. Takasao.

Monotonicity formula and Liouville theorems for stable solutions of some elliptic problems

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I will report some recent progress on the understanding of stable solutions to a class of second and fourth order nonlinear elliptic equations, such as the Liouvile theorems for stable and finite Morse index solutions and the partial regularity problems. In particular, I will discuss the application of monotonocity formula and the method of tangent cone analysis in these problems, which goes back to W. H. Fleiming. The talk is based on joint work with Juan Davila, Louis Dupaigne and Juncheng Wei.

Global bifurcation diagrams and exact multiplicity of positive solutions for a one-dimensional prescribed mean curvature problem arising in MEMS

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We study global bifurcation diagrams and exact multiplicity of positive solutions for the one-dimensional prescribed mean curvature problem arising in MEMS

$$\begin{cases} -\left(\dfrac{u'(x)}{\sqrt{1+(u'(x))^2}}\right)' = \dfrac{\lambda}{(1-u)^p}, & \begin{array}{c} u<1, \\ -L<x<L, \end{array} \\ u(-L)=u(L)=0, \end{cases}$$

where $\lambda > 0$ is a bifurcation parameter, and $p, L > 0$ are two evolution parameters. We are able to determine the exact number of positive solutions by the positive values of p, L and λ. Moreover, for $p \geq 1$, the bifurcation diagram undergoes fold and splitting bifurcations. While for $0 < p < 1$, the bifurcation diagram undergoes fold, splitting and segment-shrinking bifurcations. Our results extend and improve those of Brubaker and Pelesko (Nonlinear Anal. 75 (2012) 5086–5102) and Pan and Xing (Nonlinear Anal. Real World Appl. 13 (2012) 2432–2445) by generalizing the nonlinearity $(1-u)^{-2}$ to $(1-u)^{-p}$ with general $p \in [1,\infty)$. We also answer an open question raised by Brubaker and Pelesko on the extension of (global) bifurcation diagrams results to general $p > 0$. Concerning this open question, we find and prove that global bifurcation diagrams for $0 < p < 1$ are different to and more complicated than those for $p \geq 1$. This is joint work with Yan-Hsiou Cheng and Kuo-Chih Hung.

Synchronized and segregated solutions for coupled nonlinear Schrödinger equations

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In this talk we report recent work on new type of solutions for the coupled nonlinear Schrodinger equations. Depending upon the system being attractive or repulsive multiple (infinitely many) synchronized or segregated type solutions can be constructed, further making correlation between the coupling constants and the existence of different type of solutions.

Bubbling solutions for the Chern-Simons model

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We study the following Chern-Simons-Higgs equation:

$$\begin{cases} \Delta u + \frac{1}{\varepsilon^2} e^u (1-e^u) = 8\pi\delta_p, & \text{in } \Omega, \\ u \text{ is doubly periodic in } \partial\Omega, \end{cases}$$

where Ω is a rectangle. We show that the above problem has exactly two solutions if $\varepsilon > 0$ is small. This is a joint work with Chang-Shou Lin.

Gamma convergence for Maxwell-Chern-Simons-Higgs energy

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A gamma convergence result associated with the Maxwell-Chern-Simons-Higgs energy will be presented. As a consequence, we obtain a non-local free boundary problem, which describes the condensation of vortices in the MCSH theory. This result generalize the classical result on the mean field limit of the magnetic Ginzburg-Landau theory.

Special Session 8
Hyperbolic Conservation Laws and Related Applications

Some counterexamples in the theory of conservation laws

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The first part of the talk is concerned with sticky particle models in two space dimensions. Examples of Cauchy problems can be constructed with two and with zero solutions, respectively. Similar ideas apply to the equations of pressureless gases in two space dimensions, with L^∞ initial data.
The second set of examples concern the p-system of isentropic gas dynamics. For initial data with large total variation, one can arrange repeated wave-front interactions in such a way that the total strength of all wave fronts becomes arbitrarily large.

Nonlinear mixed type equations arisen in Mach reflection

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In the study of Mach reflection we find a kind of nonlinear mixed type equations. The solvability of the generalized Tricomi problem of the mixed type equation leads the stability of corresponding Mach configuration.

Self-similar vortex spiral solutions of the 2d incompressible Euler Equations

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Vortex spirals are ubiquitous in fluid flow, for example as turbulent eddies or as trailing vortices at aircraft wings. However, there are few proofs of existence for any of the common fluid models. We consider solutions of the incompressible Euler equations that have vorticity stratifying into algebraic spirals. The solutions are selfsimilar: velocity $v(t,x) = t^{m-1}v(t^{-m}x)$, for similarity exponent $\frac{1}{2} < m < \infty$. Selfsimilar flows are special solutions of the full initial-value problem, but obtained by solving more tractable boundary value problems. The key to the existence proof is an coordinate change which is implicit, depending on the a priori unknown solution. We will also discuss the importance of the program for showing non-uniqueness in the initial-value problem for the 2d incompressible Euler solutions.

Some results about compressible Oldroyd-B

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In this talk, I will show some results about the compressible Oldroyd-B model, which is the joint work with Ruizhao Zi. For such medel, we proved that the system admits a unique local strong solution with initial density vanishes from below, and give a blow-up criterion; In the framework of critical spaces, we establish the global solutions if the initial data and coupling constant are sufficiently small. We also proved that as the Mach number tends to zero, the global solution converges to the solution to the corresponding incompressible model in some function spaces,and obtained a kind of the converge rates.

Shock reflection and von Neumann conjectures

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We discuss shock reflection problem for compressible gas dynamics, and von Neumann conjectures on transition between regular and Mach reflections. Then we describe recent results on existence of regular reflection solutions for potential flow equation up to the detachment angle, and discuss some techniques. The approach is to reduce the shock reflection problem to a free boundary problem for a nonlinear equation of mixed elliptic-hyperbolic type. Open problems will also be discussed. The talk will be based on the joint work with Gui-Qiang Chen.

Normal forms and a Burgers-Hilbert equation

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The Burgers-Hilbert equation arises as a model equation for the motion of a vortex patch or vorticity discontinuity in a two-dimensional, inviscid, incompressible fluid flow, and describes the effect of nonlinear steepening on an interface or wave that oscillates at a constant background frequency. For small amplitudes, these oscillations delay wave breaking. We will explain how non-standard normal form methods can be used to prove an enhanced life-span of small smooth solutions of the Burgers-Hilbert equation in comparison with the inviscid Burgers equation. These normal form methods can be applied to other quasilinear wave equations, for which the Burgers-Hilbert equation provides a useful test case. This is joint work with M. Ifrim, D. Tataru, and D. Wong.

Incompressible limit of the non-isentropic ideal magnetohydrodynamic equations

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We first give a short review of results on the low Mach number limit for the compressible magnetohydrodynamic equations. Then, we study the incompressible limit of the compressible non-isentropic ideal magnetohydrodynamic equations with general initial data in the whole space $\mathbb{R}^d$ ($d = 2, 3$), and establish the existence of classic solutions on a time interval independent of the Mach number. Finally, by deriving uniform a priori estimates, we obtain the convergence of the solution to that of the incompressible magnetohydrodynamic equations as the Mach number tends to zero.
(joint-work with Q.C. Ju and F.C. Li)

The Cauchy problem to the Kazhikhov-Vaigant model in compressible flow

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In this talk, we will present some recent progresses of the global well-posedness of the Cauchy problem to the

Kazhikhov-Vaigant model which is a kind of compressible Navier-Stokes equations with the shear viscosity μ a positive constant and the bulk viscosity λ is a power function of the density.The initial data can be arbitrarily large to contain vacuum states. This is joint with Yi Wang and Zhouping Xin.

Global solutions for transonic self-similar two-dimensional Riemann problems

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We discuss the recent development of multi-dimensional transonic Riemann problems. More precisely we discuss analytical results and numerical results on a simplified model system – the nonlinear wave system.

Long Time behaviors of the Vlasov-Poisson-Boltzmann Equations

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This talk is concerned with the long time behaviors of global solution to the Vlasov-Poisson-Boltzmann (VPB) equations with binary elastic collision of hard sphere as the initial data is a small perturbation of the global Maxwellian. In terms of the spectrum analysis of linearized system and energy estimates, the optimal time decay rates of global solution is established, and the influence of electric filed governed by the self-consistent Poisson equation on the distribution of the spectra and the time-asymptotical behaviors are justified.

Traveling waves of chemotaxis models

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We study global existence and long time behavior of classical solutions for a hyperbolic-parabolic system derived from the Keller-Segel model describing chemotaxis. We establish the existence and the nonlinear stability of large-amplitude traveling wave solutions to the system of nonlinear conservation laws derived from Keller-Segel model.

Asymptotic behavior of solutions to Euler-Poisson equations for bipolar hydrodynamic model of semiconductors

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In this talk, we study the Cauchy problem for 1-D Euler-Poisson system, which represents a physically relevant hydrodynamic model but also a challenging case for a bipolar semiconductor device by considering two different pressure functions and a non-flat doping profile. Different from the previous studies for the case with two identical pressure functions and zero doping profile, we realize that the asymptotic profiles of this more physical model are their corresponding stationary waves (steady-state solutions) rather than the diffusion waves. Furthermore, we prove that, when the flow is fully subsonic, by means of a technical energy method with some new development, the smooth solutions of the system are unique, exist globally and time-algebraically converge to the corresponding stationary solutions. The optimal algebraic convergence rates are obtained.
This is a joint work with D. Donatelli, B. Rubino and R. Sampalmieri

Compressible Navier-Stokes equations with Chapman dissipation

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From its physical origin, the viscosity and heat conductivity in compressible fluids depend on absolute temperature through power laws. The mathematical theory on the well-posedness and regularity on this setting is widely open. I will report some recent progress made on this direction, with emphasis on the lower bound of temperature, and global existence of solutions in one or multiple dimensions. The relation between thermodynamics laws and Navier-Stokes equations will also be discussed. This talk is based on joint works with Weizhe Zhang.

Stability of steady state solutions for Euler-Maxwell equations

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We consider Euler-Maxwell equations arising in the modeling of magnetized plasmas. For such equations steady equilibrium states with zero velocity exist. For small initial data, we show global existence of smooth solutions with convergence toward the steady states as the time goes to infinity. In this problem, the main ingredient is an induction argument on the order of the derivatives of solutions in energy estimates. It is also efficient to obtain the global stability of solutions with exponential decay near steady states for Euler-Poisson equations.

Traveling waves for slow erosion

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We consider an integro-differential equation that describes the slow erosion of granular flow in one space dimension,

$$\begin{cases} u_t + \left(\exp \int_x^{+\infty} f(u_x(t,y))\,dy\right)_x = 0, \\ u(x,0) = \bar{u}(x). \end{cases} \tag{1}$$

Here $u(x,t)$ denotes the height of the standing profile at the point (x,t), and the time variable t denotes the amount of mass that passes through. The function $f(u_x)$ is the erosion function, which denotes the rate of erosion (or deposition if negative) per unit mass per distance travelled. In a normalized model, $f(1) = 0$, indicating a critical slope $u_x = 1$ where no erosions or depositions occur.
Due to the nonlinearity of the function f, various types of singularities will form in the solution $u(x,t)$, including kinks (jumps in u_x) and shocks (jumps in u). Existence of BV solutions is proved in [4], and semi-group solutions are established in [2], using a modified form of wave front tracking approximation. In the simpler case where u_x does not blow up, uniqueness of solutions is also achieved [1].
In this talk we construct particular forms of traveling wave solutions for (1), which connect to $x = \pm\infty$ with

critical slope $u_x = 1$. We show that, for a fixed relation of the asymptote at $x = \pm\infty$, there exists a unique traveling wave solution. Furthermore, such traveling wave solutions are local attractors. Nearby solutions approach the traveling wave asymptotically as $t \to \infty$. This is a joint work with Graziano Guerra, see [3].

[1] D. Amadori and W. Shen, *Front tracking approximations for slow erosion*, Discrete Contin. Dyn. Syst., **32** (2012), no. 5, 1481–1502.
[2] R. M. Colombo, G. Guerra, and W. Shen, *Lipschitz semigroup for an integro–differential equation for slow erosion*, Quart. Appl. Math., **70** (2012), 539–578.
[3] G. Guerra, and W. Shen, *Existence and Stability of Traveling Waves for an Integro-differential Equation for Slow Erosion* Preprint, 2013.
[4] W. Shen and T.Y. Zhang, *Erosion profile by a global model for granular flow*, Arch. Ration. Mech. Anal., **204** (2012), no. 3, 837–879.

On the existence of Meyer type transonic flows and a degenerate change type equation

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Historically, two types of smooth steady compressible irrotational transonic flows were conjectured for 2-dimensional de Laval nozzles: Taylor type and Meyer type. However, it has known since Lipman Bers that Taylor type transonic flows may not exist in general, while the existence of Meyer type transonic flows with suitable physical boundary condition has been a long standing open problem. Such a flow is governed by a quasilinear equation which changes type and becomes degenerate upon crossing sonic state where the flow may have singularities. In this talk, I will report some progress on studies of such problems. First, by investigating the properties structure of the sonic curve, in particular its exceptional points, for C^2-smooth transonic flows in a general nozzle, we show the instability of Taylor type flows and Meyer type flows with non-empty exceptional points. Then we identify a class of de Laval nozzles and suitable physical boundary conditions such that Meyer type transonic flow exists with sonic curve everywhere exceptional. Some global properties of such a solution and related open problems will be discussed.

Weakly nonlinear geometric optics for hyperbolic systems of conservation laws

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In this talk I will present a new approach to analyze the validation of weakly nonlinear geometric optics for entropy solutions of nonlinear hyperbolic systems of conservation laws whose eigenvalues are allowed to have constant multiplicity and corresponding characteristic fields to be linearly degenerate. The approach is based on our careful construction of more accurate auxiliary approximation to weakly nonlinear geometric optics, the properties of wave front-tracking approximate solutions, the behavior of solutions to the approximate asymptotic equations, and the standard semigroup estimates. This is a joint work with Guiqiang Chen and Wei Xiang of University of Oxford.

Special Session 9
Inverse Problems

Inverse scattering problems in wave propagation

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Recent progress of our research group on inverse scattering problems in wave propagation will be reported. Issues on uniqueness/stability and numerical solution for the inverse problems will be discussed.

Multi-scale full waveform inversion for seismic imaging

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The seismic imaging problem entails recovering an image of the earth's subsurface from data that is recorded on the surface of the earth, determined by the propagation of seismic (vibrational) waves through the body of the earth. The 2D or 3D acoustic wave equation is commonly used as a simplified mathematical model for this seismic wave propagation. The full waveform inverse problem aims to deduce the physical parameters of the (acoustic) medium of propagation from recorded data of impulsive waves that are transmitted or reflected through the medium, and thus form an image of the subsurface.

In this study, we demonstrate a numerical algorithm that uses factorization in the PDE solver of the 2D acoustic wave model, a multi-scale approach to the inverse solution, and a projection-based linearization search for the solution to the inverse problem. The multi-scale approach is used to decrease the rank of the inverse problem, thus decreasing the ill-posedness and under-determinedness of the solution. With a few examples, we show the robust properties of the inversion algorithm, a fast numerical convergence rate, and the advantages of multi-scaling.

Joint with Gary F. Margrave, Vladimir Zubov

On the inverse problems for the coupled continuum pipe flow model for flows in karst aquifers

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In this talk, we investigate a coupled continuum pipe flow (CCPF) model which describes the fluid flows in karst aquifers. After generalizing the well-posedness of the forward problem to the anisotropic exchange rate case which is a space-dependent variable, we present the uniqueness of this parameter by measuring the Cauchy data. Finally, some regularization schemes are provided to solve one proposed inverse problem.

A heat source reconstruction formula from single internal measurements using a family of null controls

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We consider the inverse problem of determining the spatial dependence $f(x)$ of the source term in a heat equation $u_t - \gamma\Delta u = f(x)\sigma(t)$ in $\Omega \times (0, T)$ assuming $\sigma(t)$ known,

from a single partial internal measurement of the solution in $\mathcal{O} \times (0, T)$, $\mathcal{O} \subset \Omega$. The purpose of this paper is to establish a reconstruction formula for $f(x)$ using exact controls, and that could be generalized for general parabolic equations. The reconstruction formula is associated to a family of exact controls $v(\tau)$ indexed by $\tau \in (0, T)$. We perform numerical simulations in order to illustrate the feasibility, accuracy and stability of the proposed reconstruction formula.

Inverse boundary value problems for time-harmonic acoustic waves: conditional stability and iterative reconstruction

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The inverse boundary value problem for time-harmonic acoustic waves is to determine the property of the medium inside a domain from the measurements of the displacement and normal stress on its boundary. The governing equation is the Helmholtz equation. In the partial data case, the measurements are gathered over a subset of the boundary.

In this work, we first prove a Lipschitz type stability estimate for the inverse problem assuming that the wavespeed is piecewise constant with discontinuities on a finite number of known interfaces. Then, a hierarchy algorithm is proposed and analysed for the iterative reconstruction with multi-frequency data. The algorithm is based on a projected steepest descent iteration with stability constraints. The numerical results demonstrate the proposed methodology has good performance in stability and accuracy.

Inverse problems to elliptic systems in quantitative (fluorescence) photoacoustic tomography

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We study inverse problems to two systems of elliptic equations that arise from quantitative (fluorescence) photoacoustic tomography. We present some general uniqueness and stability results following the general theory developed in [Bal, arXiv:1210.0265], as well as some explicit reconstruction strategies in simplified settings.

Recent progress in electrical tissue property MRI

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Recently, imaging techniques in science, engineering, and medicine have evolved to expand our ability to visualize internal information of an object such as the human body. In particular, there has been marked progress in MR-based electromagnetic property imaging techniques which use MRI to provide cross-sectional images of conductivity, permittivity, and susceptibility distributions inside the human body. These electromagnetic material properties of biological tissues are important biomarkers since they reveal physiological and pathological conditions of body tissues and organs. Since the conductivity and permittivity values exhibit frequency-dependent changes, it is worthwhile to perform spectroscopic imaging from almost dc to hundreds of MHz. To probe the human body, we may inject current using surface electrodes or induce current using external coils. Noting that an MRI scanner can noninvasively measure magnetic fields inside the human body, electrical tissue property imaging methods using MRI have lately been proposed. Magnetic resonance EIT (MREIT) performs conductivity imaging at dc or below 1 kHz by externally injecting current into the human body and measuring induced internal magnetic flux density data using an MRI scanner. Magnetic resonance electrical property tomography (MREPT) produces both conductivity and permittivity images at the Larmor frequency of an MRI scanner based on B1-mapping techniques. Since internal data are only available in MREIT and MREPT, we may formulate well-posed inverse problems for image reconstructions. To develop related imaging techniques, we should clearly understand the basic principles of MREIT and MREPT, which are based on coupled physics of bioelectromagnetism and MRI as well as associated mathematical methods. In this talk, we describe the physical principles of MREIT and MREPT in a unified way and associate measurable quantities with the conductivity and permittivity. Clarifying the key relations among them, we examine existing image reconstruction algorithms to reveal their capabilities and limitations. This talk is based on our recent book " Electro-Magnetic tissue property MRI" by JK Seo, EJ Woo, K Ulrich, and Y Wang.

Local lens rigidity

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We show that we can recover locally a sounds speed near a boundary point p from the lens relation (travel times) assuming that the boundary is strictly convex near p. This is a recent result with Gunther Uhlmann and Andras Vasy.

Stochastic controllability

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Controllability for dynamical systems is a typical ill-posed problem. In this talk, I will explain why the formulation of stochastic controllability problems and the tools to solve them may differ considerably from their deterministic counterpart.

Some efficient domain decomposition methods for a Class of inverse problems

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In this talk we shall present several new domain decomposition methods for solving some linear and nonlinear inverse problems. The motivations and derivations of the methods will be discussed, and numerical experiments will be demonstrated. This is a joint work with Xiao-Chuan Cai (University of Colorado at Boulder) and Hui Feng (Wuhan University) and Daijun Jiang (Huazhong Normal University). The work was supported by Hong Kong RGC grants (projects 405110 and 404611).

Special Session 10
Kinetic Equations

On some kinetic models for Bose Einstein condensation

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We present some models based on kinetic equations for describing Bose Einstein condensation. We will discuss about possible blow up or not of some of the partial differential equations. This is a joint work with Jie LIAO and Chunjin LIN.

Angular averaging, propagation of exponential tails and grazing collisions for solutions of the Boltzmann equation

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We will discuss the interplay on the collision kernels properties of the Boltzmann equation and the generation and propagation of summability of moments of the solution for the homogeneous initial value problem. Such summability yields global bounds for the solution of the Boltzmann equation by exponentially weighted norms in L^1 and pointwise, where the exponent depend on the initial state norms, the rate of the intra-molecular potentials as well as the integrability properties on the sphere (angular averaging) for the scattering angle cross-section. We will also discuss the impact of these estimates in open problems, such as the grazing collision limits to the Landau equation for Coulombic interactions. We will also show numerical simulations of these limits for different cross sections.

L^p-scattering and uniform stability of kinetic equations

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In this talk, we will review recent progress on the L^p-scattering and uniform stability of several kinetic equations with self-consistent forces. For the Vlasov equation with a self-consistent force, we will show that the Coulomb's potential in three dimensions is critical in the sense that if spatial dimension is larger than three, there exists a L^1-scattering, whereas for low dimensions less than equal to three, there is no L^1-scattering. We also present a framework for the L^p-stability of kinetic equations. This is a joint work with Sun-Ho Choi (NUS) and Qinghua Xiao (SNU).

On the spatially homogeneous Boltzmann and Landau equations

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In this talk, I will present some recent progress on the lower and upper bounds for the Boltzmann collision operator. As one application, we can build a unified framework to establish the well-posedness results for both Boltzmann and Landau equations. As another application, we will revisit the so-called "grazing collisions limit". It is shown that when almost all collisions are grazing, that is, the deviation angle θ of the collision is limited near zero (i.e., $\theta \leq \epsilon$), the solution f^ϵ of the Boltzmann equation with initial data f_0 can be globally or locally expanded as

$$f^\epsilon = f + O(\epsilon),$$

for non Coulomb potential, or

$$f^\epsilon = f + O(|\log \epsilon|^{-1}),$$

for Coulomb potential, where the function f is the solution of Landau equation, which is associated to the grazing collisions limit of Boltzmann equation, with the same initial data f_0. These give the rigorous justification of the Landau approximation in the spatially homogeneous case.

New regularity estimates for transport equations

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We present new regularity estimates which are propagated by transport equations with rough coefficients. Those estimates provides compactness on the density, which is a key ingredient to obtain existence of solutions for models from fluid mechanics (of the compressible Navier-Stokes type) to chemotaxis. The corresponding spaces are defined at a logarithmic scale in terms of number of derivatives and can thus be seen as intermediary between the usual L^p and Sobolev spaces.

Condensation and regularity for Boson Boltzmann equation

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We study the spatially homogeneous Boltzmann equation for Bose-Einstein particles for the hard sphere model. We consider the case where the initial datum of a solution of the equation is a function so that there is no condensation (Dirac mass) at the initial state. We show that if the initial datum is not very singular near the origin (the zero-point of particle energy) and if the kinetic temperature is sufficiently high, then the solution is also a function for all time, and it is a unique classical mild solution of the equation; whereas if the initial datum is singular enough near the origin but still Lebesgue integrable, then the condensation of a corresponding solution continuously starts to occur from the initial time to every later time.

Hamiltonian propagation of mono-kinetic measures with rough initial profiles

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Consider in the phase space of classical mechanics a Radon measure which is a probability density carried by the graph of a Lipschitz continuous (or even less regular) vector field. We study the structure of the push-forward of such a measure by a Hamiltonian flow. In particular, we provide an estimate on the number of folds in the support of the transported measure that is the image of the initial graph by the flow. We also study in detail the type of singularities in the projection of the transported

measure in configuration space (averaging out the momentum variable). We study the conditions under which this projected measure can have atoms, and give an example in which the projected measure is singular with respect to the Lebesgue measure and diffuse. Finally, we discuss applications of our results to the classical limit of the SchrŽdinger equation.

Scalar conservation laws and kinetic formulation

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We present a theory of Scalar Conservation Laws with rough fluxes. The difficulty is that, even with BV estimates, the equations does not make sense in disctributional sense. Our approach is based on the kinetic formulation of conservations laws.
This theory leads naturally to consider Kinetic Avergaing Lemmas with random fluxes. On simple situations we will show the differences int he gain of regularity.

This talk is based on works with P.-L. Lions and P. E. Souganidis.

Kinetic description of bacterial motion by chemotaxis and asymptotics

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Chemotaxis is the phenomenon in which cells direct their motion according to a chemical present in their environment. Since experimental observations have shown that the motion of bacteria (e.g. *Escherichia Coli*) is due to the alternation of 'runs and tumbles', mathematical modelling thanks to a kinetic description has been proposed. The starting point of the study is the so-called Othmer-Dunbar-Alt model governing the dynamics of the distribution function f of cells at time t, position x and velocity v, assumed to have a constant modulus $c > 0$, as well as the concentration $S(t, x)$ of the involved chemical. A general formulation for this model can be written as

$$\begin{cases} \partial_t f + v \cdot \nabla_x f = Q(f), \\ Q(f) = \int_{|v'|=c} \big(T[S](v', v)f(v') \\ \qquad\qquad -T[S](v, v')f(v)\big)\, dv', \\ -\Delta S + S = \rho(t, x) := \displaystyle\int_{|v|=c} f(t, x, v)\, dv. \end{cases}$$

The third equation describes the dynamics of the chemical agent which diffuses in the domain. It is produced by the cells themselves with a rate proportional to the density of cells ρ and disappears with a rate proportional to S. The transport operator on the left-hand side of the first equation stands for the unbiased movement of cells ('runs'), while the right-hand side governs 'tumbles', that is chemotactic orientation, or taxis, through the turning kernel $T[S](v', v)$, which is the rate of cells changing their velocity from v' to v.

In this work, we focus on positive chemotaxis which means that the involved chemical S is attracting cells, called chemoattractant. Existence results for this system has been obtained for various assumptions on the turning kernel. Macroscopic model can be derived from this system of equations after a rescaling. When the taxis is small compared to the unbiased movement of cells, the scaling must be of diffusive type, so that the limit equations are of diffusion or drift-diffusion type. When taxis dominates the unbiased movements, a hyperbolic limit can be derived, leading to aggregation equations. Moreover, experimental observations have shown the formation of traveling pulse of bacteria in micro-channel. The above mathematical modeling allows to recover this behaviour, which motivates the interest on such system.

Viscous wave propagation at interface

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In this talk we implement the LY algorithm to derive a two-sided master relationship. This gives rise the operator to construct the surface wave at the interface and the construction of the Green's function of a simple variable coefficient problem for viscous conservation laws.

Special Session 11
Mathematical Fluid Dynamics and Related Topics

Global solutions of the equivariant heat-flow

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The harmonic map heat-flow is a canonical, parabolic, geometric evolution equation, which is (energy) critical in two dimensions. I will present a global regularity result for the equivariant, higher-degree, above-threshold heat-flow into the sphere, which extends to higher energies earlier work with Nakanishi and Tsai on the heat and Schroedinger flows. This is joint work with Dimitrios Roxanas.

Well-posedness of coupled kinetic-fluid models for flocking

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In this talk, I will present several kinetic-fluid models for flocking. More precisely, I will discuss the dynamics of Cucker-Smale flocking particles interacting with neighboring compressible and incompressible fluid. For such coupled kinetic-fluid models, we will show global existence of weak and strong solutions and asymptotic flocking estimates for small initial data and large viscosities. This is a joint work with H.O.Bae (Ajou Univ), Young-Pil Choi (Imperial College of London) and Moon-Jin Kang (SNU).

Global classical and weak solutions to the 3D fully compressible Navier-Stokes-Fourier system

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We establish the global existence and uniqueness of classical solutions to the three-dimensional fully compressible Navier-Stokes-Fourier system with smooth initial data which are of small energy but possibly large oscillations where the initial density is allowed to vanish. Moreover, for the initial data, which may be discontinuous and contain vacuum states, we also obtain the global existence of weak solutions. These results generalize previous ones on classical and weak solutions for initial density being strictly away from vacuum, and are the first for global classical and weak solutions which may have large oscillations and can allow vacuum states.

Solvability of the initial value problem to a model system for water waves

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The water wave problem is mathematically formulated as a free boundary problem for an irrotational flow of an inviscid and incompressible fluid under the gravitational field. The basic equations for water waves are complicated due to the nonlinearity of the equations together with the presence of an unknown free surface. Therefore, until now many approximate equations have been proposed and analyzed to understand natural phenomena for water waves. Famous examples of such approximate equations are the shallow water equations, the Green–Nagdhi equations, Boussinesq type equations, the Korteweg–de Vries equation, the Kadomtsev–Petviashvili equation, the Benjamin–Bona–Mahony equation, the Camassa–Holm equation, the Benjamin–Ono equations, and so on. All of them are derived from the water wave problem under the shallowness assumption of the water waves, which means that the mean depth of the water is sufficiently small compared to the typical wavelength of the water surface.

On the other hand, it is well-known that the water wave problem has a variational structure. In fact, J. C. Luke (1967) gave a Lagrangian in terms of the velocity potential and the surface variation, and showed that the corresponding Euler–Lagrange equations are the basic equations for water waves. M. Isobe (1994) and T. Kakinuma (2000) derived model equations for water waves without any shallowness assumption. The model equations are the Euler–Lagrange equations to an approximated Lagrangian, which is obtained by approximating the velocity potential in Luke's Lagrangian.

In this talk, we consider one of the model equations and report the solvability of the initial value problem. The model are nonlinear dispersive equations and the hypersurface $t = 0$ is characteristic for the model equations. Therefore, the initial data have to be restricted in an infinite dimensional manifold in order to the existence of the solution, and we show that the manifold is invariant under the time evolution.

This talk is based on the joint research with my former student Yuuta Murakami.

Some new advances on modeling and algorithms development of multiphase complex fluid system using the phase field method

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We present some efficient modeling approach for the two phase fluid system with the variable densities and viscosities. The model, derived by employing an energetic variational approach, is thermodynamically consistent that admits an energy law. Some decoupled, energy stable schemes are developed to solve the model efficiently. Similar approach has been applied to the two phase complex fluid system, where one phase is considered to be the nematic liquid crystal. Qualitative agreements with experimental results are observed.

Classical limit of some quantum Euler equations

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In this talk, we consider classical limit problem of a class of quantum Euler equation. The classical limit describes the transition between quantum mechanics and classical mechanics (Newtonian mechanics). More specifically, we consider the compressible Euler equation with a quantum pressure, that is,

$$\begin{cases} \partial_t \rho + \mathrm{div}\rho v = 0, \\ \partial_t(\rho v) + \mathrm{div}(\rho v \otimes v) + \rho \nabla P(\rho) = \hbar^2 \rho \nabla \left(\dfrac{\Delta\sqrt{\rho}}{\sqrt{\rho}} \right), \\ \rho(0,x) = \rho_0(x), \quad v(0,x) = v_0(x), \end{cases} \tag{2}$$

for $(t,x) \in \mathbb{R}_+ \times \mathbb{R}^N$, where $\rho = \rho(t,x)$ and $v = v(t,x)$ denote the mass density and the velocity vector, respectively. (ρ_0, v_0) is a given initial data independent of $\hbar$. P stands for the pressure. In this talk, we mainly consider the pressure given by the Poisson equation; $P(\rho) = c(-\Delta)^{-1}\rho$ with some constant c. In this case, (2) is often referred to as an Euler-Poisson equations. The right hand side of the second line of (2) is the quantum pressure. $\hbar$ is a positive parameter which corresponds to the scaled Planck constant. Our problem is analysis of the limit $\hbar \to 0$ (the classical limit). At least formally, a solution (ρ, v) of (2) tends to a solution of the usual Euler equation

$$\begin{cases} \partial_t n + \mathrm{div} n w = 0, \\ \partial_t(nw) + \mathrm{div}(nw \otimes w) + n\nabla P(n) = 0, \\ n(0,x) = \rho_0(x), \quad w(0,x) = v_0(x). \end{cases} \tag{3}$$

for $(t,x) \in \mathbb{R}_+ \times \mathbb{R}^N$. Our purpose is to establish sufficient existence results for (2) and (3) and to justify this limit. The difficulty of (2) lies in the treatment of the quantum pressure term. Since this pressure contains the density ρ as a denominator, we have to care about the existence of vacuum (zero points of ρ).

In this talk, we restrict our attention to the irrotational flow case, in which case (2) is an alternative formulation of Schrödinger equation (the Madelung equation), and analyze (2) by using a complex square root of the density. This method is introduced by Grenier in 1998 in order to justify the semiclassical limit of the cubic nonlinear Schrödinger equation. Let $a(t,x)$ be a $\mathbb{C}$-valued function and $u(t,x)$ be an $\mathbb{R}^N$-valued function. We work with the following system.

$$\begin{cases} \partial_t a + u \cdot \nabla a + \dfrac{1}{2} a \nabla \cdot u = \dfrac{i\hbar}{2} \Delta a, \\ \partial_t u + (u \cdot \nabla) u + \nabla P(|a|^2) = 0, \\ a(0,x) = \sqrt{\rho_0(x)}, \quad u(0,x) = v_0(x). \end{cases} \tag{4}$$

for $(t,x) \in \mathbb{R}_+ \times \mathbb{R}^N$. The heart of matter is that if (a,u) solves this system then $(\rho, \rho v) = (|a|^2, |a|^2 u + \hbar \mathrm{Im}(\overline{a}\nabla a))$ becomes a solution to (2) (at $(t,x) \notin \{a(t,x) = 0\}$). By this method, besides the justification of the limit $(\rho, \rho v) \to (n, nw)$ as $\hbar \to 0$, we obtain an asymptotic expansion of $(\rho, \rho v)$ in the classical limit. We remark that the presence of vacuum makes no trouble when we solve (4) since the quantum pressure now changes into a dispersion term.

Asymptotic stability of mild solutions to the Navier-Stokes equations

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We consider the initial value problem for the Navier-Stokes equations modeling an incompressible fluid in three dimensions:

$$u_t + u \cdot \nabla u + \nabla p = \Delta u + f, \quad (x,t) \in \mathbb{R}^3 \times (0, \infty),$$

$$\text{div } u = 0,$$
$$u(x, 0) = u_0(x)$$

It is well-known that this problem has a unique global-in-time mild solution for a sufficiently small initial condition u_0 and for a small external force F in suitable scaling invariant spaces. We show that these global-in-time mild solutions are asymptotically stable under every (arbitrary large) l^2-perturbation of their initial conditions. The work is joint with Grsegorz Karch and Dominika Pilarczyk.

On vanishing viscosity limit for 3-Dimensional incompressible Navier-Stokes equations with a slip boundary condition

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In this talk, we will discuss the problem of vanishing viscosity limit for 3-dimensional incompressible Navier-Stokes equations in a general bounded smooth domain with general Navier-Slip boundary conditions. The focus will be on the convergence of viscous solutions to the inviscid ones in the space $C([0, T], H^1(\Omega))$. Some uniform estimates on the rate of convergence will be presented.

Topological instability of laminar flows for the two-dimensional Navier-Stokes equation with circular arc no-slip boundary conditions

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In this talk we show that a diffuser-shaped boundary induces the reverse flow even near the entrance of the diffuser. Let us be more precise. We consider the two-dimensional Navier-Stokes equation in $\Omega \subset R^2$ (define Ω later) with no-slip and inflow-outflow conditions on $\partial\Omega$. We need to handle a shape of the boundary $\partial\Omega$ precisely, thus we set a parametrized smooth boundary $\varphi : (0, S) \to R^2$ as $|\partial_s\varphi(s)| = 1$, $|\partial_s^2\varphi(s)| = \kappa$ (curvature), $\varphi(0) = (0, 0)$, $\partial_s\varphi(0) = (1, 0)$, $\partial_s^2\varphi(0) = (0, -\kappa)$. We choose S later (should be sufficiently small). We define $n = n(s) := (\partial_s\varphi(s))^\perp$ as a unit normal vector and $\tau = \tau(s) = \partial_s\varphi(s)$ as a unit tangent vector, where $\perp$ represents upward direction.

Global strong solution for equations related to the incompressible viscoelastic fluids

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Considering a system related to the incompressible viscoelastic fluids of Oldroyd–B type,

$$\begin{aligned}
&\nabla \cdot v = 0, \quad (t, x) \in \mathbf{R}^+ \times \mathbf{R}^N, \ N \geq 2,\\
&v_{it} + v \cdot \nabla v_i + \partial_i \Pi = \mu \Delta v_i + E_{jk}\partial_j E_{ik} + \partial_j E_{ij},\\
&E_t + v \cdot \nabla E = \nabla v E + \nabla v,\\
&(v, E)(0, x) = (v_0, E_0)(x),
\end{aligned}$$

we investigate the global existence of the strong solutions with some classes of large initial data $E_0 = [E_{0,ij}]_{i=1,\ldots,N;j=1,\ldots,N}$, $v_0 = [v_{01}, \ldots, v_{0N}]^\top$. We obtain the global existence and uniqueness of solution provided that $(\bar{E}_0, \bar{v}_0)$ are sufficient small in $(\dot{B}_{2,1}^{\frac{N}{2}-1} \cap \dot{B}_{2,1}^{\frac{N}{2}}) \times \dot{B}_{2,1}^{\frac{N}{2}-1}$, while E_{0N} and v_{0N} are large, where $\bar{E}_0 = [E_{0,ij}]_{i=1,\ldots,N-1;j=1,\ldots,N}$, $\bar{v}_0 = [v_{01}, \ldots, v_{0,N-1}]^\top$ and $E_{0N} = [E_{0,N1}, \ldots, E_{0,NN}]$.

Special Session 12
Mathematics of String Theory

Stacky resolutions of the moduli spaces of instantons on ALE spaces

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Moduli spaces of framed sheaves on the complex projective plane are a resolution of singularities of the moduli space of ideal instantons on the 4-sphere. Another instance of this phenomenon is provided by the moduli space of framed sheaves on the blowup of the projective plane, which resolves the singularities of the moduli space of ideal instantons on the orientation-reversed projective plane. This fact is used extensively in super Yang-Mills topological quantum field theories, where the instanton moduli spaces classify the classical vacua, in particular to compute Nekrasov partition functions and other invariants.
A natural question arises whether similar constructions can be made in the case of other spaces. I will consider instantons on the ALE spaces X of type A_k. Here the nontrivial behaviour of the instantons at infinity makes it necessary to consider moduli spaces of framed sheaves on a DM projective stack whose coarse moduli space is a toric compactification of X. In particular one needs to introduce a so-called root stack which has a gerby behaviour over the compactifying divisor.

Topology change from heterotic Narain T-duality

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I will describe topology changing Narain T-dualities on torus-fibered compactifications with H flux in type II and heterotic string theories. In heterotic string theories, such T-dualities mix the topology of the gauge bundle with that of spacetime consistently with the supersymmetry conditions. More precisely, T-duality mixes half of the field strength of an unbroken $U(1)$ gauge symmetry with the antiselfdual part of the curvature of the fibration of compactified circle.

Equivariant Cohomology and Bismut-Chern Character in the Stolz-Teichner Program

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Abstract: The Stolz-Teichner program aims to relate supersymmetric field theories to generalized cohomology theories. In this talk, we will describe our joint projects with Chris Schommer-Pries, Stephan Stolz and Peter Teichner, relating 0|1-dimensional gauged field theories to the equivariant cohomology of manifolds with Lie group actions and realizing the Bismut-Chern character as dimension reduction functor.

T-duality commutes with reduction

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T-duality is a discrete symmetry in string theory that relates topologically distinct torus fibrations and provides a dictionary for translating geometrical structures between them. The duality is mathematically well-understood in type II theories and the purpose of this talk is to explain how it can be extended to the heterotic setting. The setup naturally involves string structures and reduction of Courant algebroids. This is joint work with David Baraglia.

A motivic approach to Potts models

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The use of motivic techniques in Quantum Field Theory has been widely explored in the past ten years, in relation to the occurrence of periods in the computation of Feynman integrals. In this lecture, based on joint work with Aluffi, I will show how some of these techniques can be extended to a motivic analysis of the partition function of Potts models in statistical mechanics. An estimate of the complexity of the locus of zeros of the partition function, can be obtained in terms of the classes in the Grothendieck ring of the affine algebraic varieties defined by the vanishing of the multivariate Tutte polynomial, based on a deletion-contraction formula for the Grothendieck classes.

The Wess-Zumino-Witten model on $\mathsf{SL}(2;\mathbb{R})$

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The prototypical examples of string theories on target spaces with non-trivial topologies are the Wess-Zumino-Witten (WZW) models for which the target is a compact reductive Lie group. However, the non-compact case is physically more relevant and is mathematically richer as well. While the pioneering work of Maldacena and Ooguri proposed string spectra and proved a no-ghost theorem for the WZW model on $\mathsf{SL}(2;\mathbb{R})$, recent work has shown that the underlying conformal field theory is far richer, at least for certain levels, and provides an example of a so-called *logarithmic* conformal field theory. This talk will review this recent work and what it suggests for other theories with non-compact target spaces.

M-branes and higher bundles

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We describe the M-branes in M-theory via higher geometry, including String structures, String bundles with connections, higher (stacky) notions of Chern-Simons theory, and relation to higher WZW models. This is joint work with Domenico Fiorenza and Urs Schreiber.

T-duality for circle bundles via noncommutative geometry

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It is known that topological T-duality can be extended to apply not only to principal circle bundles, but also to non-principal circle bundles. We show that this result can also be recovered via the noncommutative geometry approach which we previously used for principal torus bundles. This work has several interesting byproducts, including a study of the K-theory of crossed products by $\widetilde{O}(2) = \mathrm{Isom}(\mathbb{R})$, the universal cover of $O(2)$, and some interesting facts about equivariant K-theory for $\mathbb{Z}/2$. These results are then extended to the case of bundles with singular fibers, or in other words, non-free $O(2)$-actions. This is joint work with Jonathan Rosenberg.

Special Session 13
Measurable and Topological Dynamics

Height reducing problem

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We say that an algebraic number α has height reducing property (HRP) if there is a positive integer B that $Z[\alpha] = B[\alpha]$, i.e., every number in $Z[\alpha]$ has an equivalent representation with coefficients in $\{-B, \ldots, B\}$. This problem is studied for algebraic integers, since it has intimate connection to the construction of self-affine tilings. In this talk, we consider HRP for general algebraic numbers and obtain some 'almost' if and only if condition for HRP. The proof relies on a quantitative version of Kronecker's approximation theorem. This is a joint work with Toufik Zaimi.

Large deviation principle for chaotic dynamical systems

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We will discuss a class of chaotic dynamical systems for which the full large deviation principle holds. It contains intermittent maps and quadratic maps on intervals, almost Anosov diffeomorphisms on tori and countable Markov shifts with return time functions of 'gentle' slopes.

Chaotic dynamics of continuous-time topological semiflow on Polish space

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Differently from Li-Yorke and others in literature, we will introduce the concept—chaos—for a continuous semiflow $f\colon R_+ \times X \to X$ on a Polish space X without isolated points, which is useful for the theory of ODE and is invariant under topological equivalence. Our definition is weaker than Devaney's since here f may have neither fixed nor periodic elements; but it still implies the sensitive dependence on initial data similar to Devaney's chaos. We will show that f always has a maximal chaotic subsystem. In addition, we will consider the chaotic behavior on minimal center of attraction of a motion.

Random dynamical systems

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In joint work with Guo-Hua Zhang, we have extended the notion of random dynamical system from $\mathbf{Z}$ actions to actions of discrete amenable groups.

In this setting, we introduce local fiber topological pressure and establish a variational principle related to measure-theoretic entropy.

One can then define both topological and measure-theoretic entropy tuples, and apply the variational principle to obtain a relationship between them. These results recover and extend many recent results in local entropy theory.

Local entropy dimension for a measure and a variational principle

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The notion of entropy dimension measures the subexponential complexity of entropy zero dynamical systems. By considering topological entropy via hausdorff dimension and measure-theoretical local entropy, we introduce Bowen's type entropy dimension $D^B(T,K)$ and local (lower) entropy dimension $\underline{D}_\mu^{loc}(T)$ in entropy zero systems. When restrict to a compact subset K, we prove the following variational principle: $D^B(T,K) = \sup\{\underline{D}_\mu^{loc}(T) : \mu \in M(X), \mu(K) = 1\}$.

Decomposition problems in symbolic dynamics

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A code is a homomorphism between shift dynamical systems. Problems concerning decompositions of one code into a composition of several codes were considered in symbolic dynamics for coding purpose. Although a lot is known about the decompositions of factor codes between subshifts with equal entropy, not much is known for the case of unequal entropies. The first part of the talk will be devoted to the history and known results on the decomposition problems. For the remaining part, our recent developments will be presented. Especially we focus on the set of possible entropies of intermediate subshifts arising from decomposing a given code. This is a joint work with Soonjo Hong and In-Je Lee.

Overlap and strong coincidences on substitution tilings

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Pisot number is an algebraic integer whose all the other Galois conjugates are less than 1 in absolute. Substitution sequences can be constructed replacing a letter by a word from a given finite letters. Incidence matrix is defined by the numbers of letters coming from each letter. If the largest eigenvalue of this matrix is a Pisot number, we say that the substitution is "Pisot". We construct a tiling space collecting all the locally indistinguishable tiling from the given Pisot substitution tiling.

It has been conjectured that the tiling space of a Pisot substitution tiling whose substitution matrix is irreducible has discrete dynamical spectrum. This is called "Pisot substitution conjecture" which has not been solved for many years. Many notions of coincidences in substitution tilings have been introduced in the study of the discrete dynamical spectrum of the tiling spaces.

Here we consider two well-known coincidences in the area, namely overlap coincidence and strong coincidence, whose relations are not completely understood. We establish one direction of the implication from overlap coincidence to strong coincidence.

Subword complexity and Sturmian colorings of trees

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In this talk, we introduce subword complexity of colorings of regular trees. We characterize colorings of bounded subword complexity and then introduce Sturmian colorings, which are colorings of minimal unbounded subword complexity.

We classify Sturmian colorings using their type sets. We show that any Sturmian coloring is a lifting of a coloring on a quotient graph of the tree which is a geodesic or a ray, with loops possibly attached, thus a lifting of an "infinte word". We further give a complete characterization of the quotient graph for eventually periodic ones. We will provide several examples. This is a joint work with Dong Han Kim.

Shadowing properties with average tracing of pseudo-orbits.

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Average shadowing properties generalize standard definitions of shadowing (e.g. shadowing property, limit shadowing property, etc.) by controlling average error of tracing instead of its control in each iteration. Clearly, the definition of pseudo-orbit have to be modified accordingly. This modification enables application of average shadowing in dynamical systems where we cannot control error in each step, but we can ensure that average error is sufficiently small. In particular, there are maps with average shadowing property but without shadowing property (and vice-versa).

In this talk we will survey recent results on average shadowing properties. We will present a few sufficient conditions that ensure average shadowing and comment on relations between average shadowing and notions from topological dynamics, like shadowing property, mixing, specification, proximality and the like.

Higher order Bohr problem and related topics

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In this talk we will discuss higher order Bohr problem and related questions. An old problem about Bohr sets says that for any syndetic set S, is the set $S - S$ a Bohr_0 set? We study the higher order version of this problem: for any d does the common difference of arithmetic progression with length $d+1$ appeared in a syndetic set coincide with a Nil_d Bohr_0 set? We show that one side of this question holds: for any Nil_d Bohr_0-set A, there exists a syndetic set S such that A contains the common difference of arithmetic progression with length $d+1$ appeared in S. And we show that other side of the problem can be deduced from some result by Bergelson-Host-Kra if modulo a set with zero density. This is a joint work with W. Huang and X.D. Ye.

Negativity of Lyapunov exponents in generic random dynamical systems of complex polynomials

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In this talk, we consider random dynamical systems of complex polynomial maps on the Riemann sphere $\hat{C}$. It is well-known that for each rational map f on $\hat{C}$ with $\deg(f) \geq 2$, the Julia set $J(f)$ is a non-empty perfect compact subset of $\hat{C}$ (thus $J(f)$ contains uncountably many points), $f : J(f) \to J(f)$ is chaotic (at least in the sense of Devaney), and

$$\dim_H(\{x \in \hat{C} \mid \liminf_{n\to\infty} \tfrac{1}{n} \log \|Df^n(x)\| > 0\}) > 0,$$

where $\dim_H$ denotes the Hausdorff dimension with respect to the spherical distance on $\hat{C}$ and $\|\cdot\|$ denotes the norm of the derivative with respect to the spherical metric on $\hat{C}$. **However**, we show that for **generic** i.i.d. random dynamical systems of complex polynomials, all of the following (1) and (2) holds.

(1) For all points $x \in \hat{C}$, the orbit of the Dirac measure δ_x at x under the dual of the transition operator of the system converges to a periodic cycle of probability measures on $\hat{C}$.

(2) For all but countably many points $x \in \hat{C}$, for almost every sequence $\gamma = (\gamma_1, \gamma_2, \gamma_3, \cdots)$ of polynomials, the Lyapunov exponent along γ starting with x is negative. More precisely, there exists a constant $c < 0$, which depends only on the system, such that for all but countably many points $x \in \hat{C}$, for almost every sequence $\gamma = (\gamma_1, \gamma_2, \gamma_3, \cdots)$ of polynomials,

$$\chi(\gamma, x) := \lim_{n\to\infty} \tfrac{1}{n} \log \|D(\gamma_n \circ \cdots \circ \gamma_1)(x)\| \text{ exists and } \chi(\gamma, x) \leq c.$$

Note that each of (1) and (2) **cannot hold in the usual iteration dynamics** of a single rational map f with $\deg(f) \geq 2$. Therefore **the picture of the random complex dynamics is completely different from that of the usual complex dynamics**. We remark that even the chaos of the random system disappears in C^0 sense, the chaos of the system may remain in C^1 sense, and we have to consider the "gradation between the non-chaoticity and the chaoticity".

References

[1] H. Sumi, Random complex dynamics and semigroups of holomorphic maps, Proc. London. Math. Soc. (2011), 102 (1), 50–112.

[2] H. Sumi, Cooperation principle, stability and bifurcation in random complex dynamics, preprint, http://arxiv.org/abs/1008.3995.

The semi-classical zeta function for contact Anosov flow

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We consider the semi-classical (or Gutzwiller-Voros) zeta function for a C^∞ contact Anosov flow. This is defined by the formula

$$Z_{sc}(s) = \exp\left(- \sum_{\gamma\in\Gamma} \sum_{m=0}^{\infty} \frac{e^{-s\cdot m\cdot|\gamma|}}{m \cdot |\det(\mathrm{Id} - D_\gamma^m)|^{1/2}} \right)$$

where Γ is the set of prime periodic orbits. ($|\gamma|$ and D_γ denote the prime period and the transversal Jacobian of $\gamma \in \Gamma$ respectively.)

Investigating the spectrum of transfer operators associated to the flow, we prove that the zeros of $Z_{sc}(s)$ are contained in the region

$$\{s \in \mathbf{C} \mid |\Re(s)| < \tau \text{ or } \Re(s) < -\chi_0 + \tau\}$$

for arbitrarily small $\tau > 0$ up to finitely many exceptions, where χ_0 is the hyperbolicity exponent of the flow. Further we show that the zeros in the strip $\{s \in \mathbf{C} \mid |\Re(s)| < \tau\}$ satisfy an analogue of the Weyl law. These results can be regarded as a generalization of a classical result of Selberg on the zeta function named after him.

Local weak mixing in dynamical systems

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By a topological dynamical system we mean a compact metric space equipped with a continuous self-map. Given a topological dynamical system, people are interested in the study of complexity of the system (and its subsets). To understand the complexity of a subset, in this talk, I shall discuss the local weak mixing behavior in the system based on several joint papers with Piotr Oprocha.

Special Session 14
Multiscale Analysis and Algorithms

A hybrid method for solving Laplace equations with Dirichlet data using local boundary integral equations and random walks

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In this talk, we will present a new approach for solving Laplace equations in general 3-D domains. The approach is based on a local computation method for the DtN mapping of the Laplace equation by combining a deterministic (local) boundary integral equation method and the probabilistic Feynman-Kac formula of PDE solutions. This hybridization produces a parallel algorithm where the bulk of the computation has no need for data communications. Given the Dirichlet data of the solution on a domain boundary, a local boundary integral equation (BIE) will be established over the boundary of a local region formed by a hemisphere superimposed on the domain boundary. By using a homogeneous Dirichlet Greenạ́s function for the whole sphere, the resulting BIE will involve only Dirichlet data (solution value) over the hemisphere surface, but over the patch of the domain boundary intersected by the hemisphere, both Dirichlet and Neumann data will be used. Then, firstly, the solution value on the hemisphere surface is computed by the Feynman-Kac formula, which will be implemented by a Monte Carlo walk on spheres (WOS) algorithm. Secondly, a boundary collocation method is applied to solve the integral equation on the aforementioned local patch of the domain boundary to yield the required Neumann data there. As a result, a local method of finding the DtN mapping is obtained, which can be used to find all the Neumann data on the whole domain boundary in a parallel manner. Finally, the potential solution in the whole space can be computed by an integral representation using both the Dirichlet and Neumann data over the domain boundary.

(joint work with Changhao Yan and Xuan Zeng, microelectronics, Fudan University)

Solving nonlinear eigenvalue problem in resonant tunneling diodes

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In this talk, we propose a deflation strategy for solving the nonlinear eigenvalue problem in resonant tunneling diodes with multi-mode approximation. Numerical experiments show the efficiency of our method. This is a joint work with Shengyao Xu.

Quantum, kinetic and hydrodynamic descriptions on spin transfer torque

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Magnetic storage devices rely on the fact that ferromagnetic materials are typically bistable, and that it is possible to switch between diïňĂerent states by applying a magnetic ïňĄeld. The discovery of the Giant MagnetoResistance eïňĂect has enabled the use of layered ferromagnetic materials in magnetic devices, such as magnetic memories (MRAMs). Even in the absence of thermal eïňĂects, there are limitations in the storage capacity of such devices due to the fact that as the size is decreased, the magnitude of the switching ïňĄeld increases, due to an increase in shape anisotropy. Given that magnetic ïňĄelds have long range interactions, the density of such devices is limited.

A new mechanism for magnetization reversal in multilayers was proposed by Slonczweski and Berger. In this new mechanism, an electric current ïňĆows perpendicular to the layers. The current is polarized in the ïňĄrst layer, and the polarization travels with the current to the second layer, where it interacts with the underlying magnetization. Since currents are localized in each cell, long range eïňĂects can be reduced.

In this talk we will discuss the connection between several models for the description of the *spin transfer torque* at different physical scales. Specifically, we connect the quantum and kinetic descriptions with the help of the Wigner transform, and the kinetic and diffusion models by a specific parabolic scaling. Numerical examples will presented to illustrate the applicability and limit of the different models.

This is joint work with Jingrun Chen and Xu Yang at UCSB.

From discrete velocity model to moment method

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In the numerical approaches for Boltzmann equation, the discrete velocity model and the moment method are formally very different. The difference is so big that the communities working on the two approaches are in certain competitive relation. In this talk, I will try to show the intrinsic connection between these two approaches. Precisely, the Grad type moment method with appropriate closure can be regarded as a discrete velocity model with some adaptivities in setup of the velocity points. The globally hyperbolic regulazation of the moment method plays an essential role in connecting both approaches together.

Atomic level interpretation of fracture criteria

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Fracture in brittle materials has been a subject of intensive studies following the pioneering works of Griffith and Irwin. The propagation of a crack is often predicted based on the energy release rate or the stress intensity factors. This talk will present our recent studies of crack propagation in the framework of bifurcation theory. This has been motivated by the fact that structural stability is a well-defined concept in the theory of bifurcation. The bifurcation study is based on molecular dynamics models, which provide a direct microscopic view of the critical events in the process of fracturing. More importantly, we will re-interpret several important concepts in the conventional fracture mechanics.

Multiscale modeling and computation of nano optical responses

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We introduce a new framework for the multiphysical modeling and multiscale computation of nano-optical responses. The semi-classical theory treats the evolution of the electromagnetic field and the motion of the charged particles self-consistently by coupling Maxwell equations with Quantum Mechanics. To overcome the numerical challenge of solving high dimensional many body Schr odinger equations involved, we adopt the Time Dependent Current Density Functional Theory (TD-CDFT). In the regime of linear responses, this leads to a linear system of equations determining the electromagnetic eld as well as the current and electron densities simultaneously. A self-consistent multiscale method is proposed to deal with the well separated space scales. Numerical examples arepresented to illustrate the resonant condition.

Convergence of force-based atomistic-to-continuum methods

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The numerical analysis of atomistic-to-continuum methods, in particular, for two or three dimensional systems, is challenging and important for understanding multiscale methods for solids. In this talk, we will discuss some recent progress in stability and convergence analysis of force-based hybrid methods coupling together atomistic models and Cauchy-Born elasticity with smooth and sharp transitions. We will focus on the requirement of stability conditions due to interfaces. (Joint work with Pingbing Ming)

Ghost forces for multiscale coupling methods in solids

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In this talk, I will report some recent progress on the ghost force issue for multiscale coupling methods in solids. Quantitative estimates for the influence of the ghost force will be presented. Examples for high dimensional problems, dynamic problem and the crack problem will be discussed.

The growing string method for saddle point search

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The string method was originally designed for finding minimum energy paths between two minima on a potential (or free) energy landscape. It evolves a continuous curve in the path space by the steepest descent dynamics. In this talk, we discuss how the string method can be modified to find saddle points of a potential energy using a minima as the only input. Compared to the existing algorithms, the new method has the advantage that the computed saddle points are guaranteed to be directly connected to the minima. We will also discuss the acceleration of the convergence using an inexact Newton method. Applications to the diffusion of a cluster of atoms on a solid substrate and the wetting transition of a droplet on a rough surface will be presented.

Multiscale methods for wave propagation problems

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Multiscale wave propagation problems are computationally costly to solve by traditional techniques because the smallest scales must be represented over a domain determined by the largest scales of the problem. We consider numerical methods for multiscale wave propagation in the framework of the heterogeneous multiscale method. These methods couple simulations on macro- and microscales for problems with rapidly oscillating coefficients. The complexity is significantly lower than that of traditional techniques with a computational cost that is essentially independent of the microscale. In this talk we show analysis of how the method works in the long time case, where the macroscale solution show dispersive behavior, and how the method, although designed for wave problems, can be beneficial for solving multiscale elliptic problems.

Modeling and simulation of three-component flows on solid surface

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We propose a phase field model for the study of three-component immiscible flows with boundary. The model is a generalization of the two-component model. We first study certain consistency conditions for the forms of the bulk free energy and surface energy. We then develop an adaptive mesh refinement(AMR) technique to solve the system in order to improve the efficiency of the problem. Several numerical results are given, including the liquid lens spreads between two phases, the buoyancy-driven droplet through a fluid-fluid interface, spreading of a compound droplet on a stationary substrate, and shear flows of a compound droplet on a channel.

A path way based mean field model for E. coli chemotaxis

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In this talk, we give a mathematical derivation of a pathway- based mean-field model for E. coli chemotaxis based on the moment closure in kinetic theory. The pathway based model incorporate the most recent intracellular chemical dynamics. The derived moment system, under some assumptions, gets to the chemotaxis model proposed in [G. Si, T. Wu, Q. Quyang and Y. Tu, Phys. Rev. Lett., 109 (2012), 048101], especially an important physical assumption made in which can be understood explicitly in this new moment system. We obtain the Keller-Segal limit by considering the moment system in the regime of long time and strong tumbling rate. Numerical experiments are presented to show the agreement of the moment system with (individual based) signaling pathway- based E. coli chemotaxis simulator ([L. Jiang, Q. Ouyang and Y. Tu, PLoS Comput. Biol., 6 (2010), e1000735]).

Generalized Irving-Kirkwood formula for the calculation of continuum quantities in molecular dynamics models

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Continuum mechanics quantities can be computed from molecular dynamics (MD) models based on the classical Irving-Kirkwood (IK) formalism. Practical implementations of IK formulas involve a spatial averaging using a smooth kernel function. The obtained results usually need to be further processed to reduce the fluctuation, e.g., by ensemble or time averaging. In this talk the IK formalism is extended to systematically incorporate both spatial and temporal averaging into the expression of continuum quantities. We will present the results both in Lagrangian and Eulerian coordinates.

Special Session 15
Number Theory and Representation Theory

On a classification of irreducible modulo p representations of p-adic groups

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Barthel-Livné introduced the notion of modulo p supersingular representations of GL_2. It is generalized to split groups by Herzig and to connected reductive groups by Henniart and Vignéras. In this talk, we discuss about a classification of irreducible modulo p representations in terms of supersingular representations.

This is joint work with G. Henniart, F. Herzig and M.-F. Vignéras.

Parity sheaves on the affine Grassmannian and the Mirković–Vilonen conjecture

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The *geometric Satake equivalence* gives a realization of the category of representations of a split reductive algebraic group over any field in terms of perverse sheaves on the affine Grassmannian for the dual group. In this setting, Mirković and Vilonen conjectured that the perverse sheaves corresponding to Weyl modules should enjoy a parity-vanishing property, similar to that of ℓ-adic intersection cohomology complexes. This conjecture has now been proved (with a few exceptions in small characteristics) in joint work with Laura Rider. I will discuss the ingredients in the proof, along with potential applications of our techniques to questions in modular representation theory.

Rectifiers and the local Langlands correspondence

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Abstract: In this talk, I will recall the notion of a rectifier as in the work of Bushnell/Henniart in the local Langlands correpsondence for GL(n). I will then propose a definition for rectifier for general unramified groups G. I will describe rectifiers in this setting, and show that our definition agrees with Bushnell/Henniart's in the depth zero case. This is joint work with David Roe.

Uniform in p estimates for orbital integrals

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This talk is about a method, based on model theory, that can be used to get some uniform in p estimates for integrals over p-adic fields in the cases when it is hard to see directly how such integrals behave for different places p.

One example of such a situation is orbital integrals on p-adic groups. Let G be a reductive p-adic group. It was proved by Harish-Chandra that the orbital integrals, normalized by the discriminant, are bounded (for a fixed test function). However, it is not easy to see how this bound behaves if we let the p-adic field vary (for example, if the group G is defined over a number field F, and we consider the family of groups $G_v = G(F_v)$, as v runs over the set of finite places of F), and how it varies for a family of test functions. Using a method based on model theory and motivic integration, we prove that the bound on orbital integrals can be taken to be a fixed power (depending on G) of the cardinality of the residue field. This statement has an application to the recent work of S.-W. Shin and N. Templier on counting zeroes of L-functions. This project is joint work with R. Cluckers and I. Halupczok.

On the center of Lie algebras

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I will discuss the center of the universal enveloping algebra of four different kinds of Lie algebras:
(1) Harish-Chandra's description of the centre of a simple algebra $\mathfrak{g}$.
(2) Duflo-Kirillov's description of the centre of an arbitrary finite dimensional algebra.
(3) Center of the algebra of jets $\mathfrak{g}[[t]]$ and $\mathfrak{g}((t))$.
(4) Feigin-Frenkel description of center of the vertex Lie algebra associated to $\mathfrak{g}$, via Langlands dual group.

I will then define the notion of quasi-Verma modules for the abovementioned vertex algebra, and stipulate how the Feigin-Frenkel Center should act on these modules.

A homological study of Green polynomials

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We first explain how to categorify the Green/Kostka polynomials of reductive groups. Then, we discuss how they are related to the relevant orthogonality relation of some modules of affine Hecke algebras and p-adic groups, and their consequences.

On the structure of Selmer groups

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As a refinement of Iwasawa theory, which gives a refined relationship than the usual main conjecture between Selmer groups and p-adic L-functions, I describe the structure as an abelian group of the classical Selmer group of an elliptic curve, using modular symbols. I also talk on Euler systems and Kolyvagin systems of Gauss sum type, which give nontrivial elements in Galois cohomology groups.

On the first Betti number of hyperbolic arithmetic manifolds

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In the 1970's Thurston conjectured that every hyperbolic manifold admits a finite cover with non-zero first Betti number. In the arithmetic case, this property is related to the congruence subgroup problem for $\mathrm{SO}(n,1)$. For arbitrary dimension n there are two types of arithmetic hyperbolic manifolds, which arise from either quadratic forms over totally real number fields, or skew-hermitian forms over certain quaternion algebras. In 1976 Millson proved Thurston's conjecture for the first type of arithmetic hyperbolic manifolds using geometric methods. For the second type of manifolds, similar results were established in the 1990's .

In this talk we will briefly review this history, and discuss an improved version of an old construction which leads to some modest related results. We will also discuss some related open problems.

On the elliptic part of the trace formula for $\widetilde{\mathbf{Sp}}(2n)$

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In this talk, I will introduce the stabilization of Arthur-Selberg trace formula for reductive groups and its applications, then proceed to its generalization to the metaplectic twofold cover $\widetilde{\mathrm{Sp}}(2n)$ of $\mathrm{Sp}(2n)$. Based on the recent progress on geometric transfer and the invariant trace formula for metaplectic group, I will explain the stabilization of the elliptic terms in the trace formula of $\widetilde{\mathrm{Sp}}(2n)$.

Endoscopic classification of automorphic representations of classical groups

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We will give an exposition of the recent works on endoscopic classification of automorphic representations for classical groups. Some recent arithmetic applications of the endoscopic classification will be discussed.

Twisted spectral transfer for real groups

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Kottwitz and Shelstad generalized the framework of endoscopy to include twisting by group automorphisms or central characters. This generalization contained conjectural identities between orbital integrals, constituting a transfer from functions on a group to functions on one of its endoscopic groups. This geometric transfer has recently been proven by Shelstad. Dual to geometric transfer is spectral transfer, which is a collection identities between characters of L-packets of a group and one of its endoscopic groups. We show how some work of Bouaziz, Duflo and Shelstad may be adapted to the twisted endoscopy of real reductive groups in order to achieve spectral transfer.

Zelevinsky involution and ℓ-adic cohomology of Rapoport-Zink spaces

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Rapoport-Zink spaces are certain moduli spaces of quasi-isogenies of p-divisible groups with additional structures, and can be regarded as local analogues of Shimura varieties. It is conjectured that the ℓ-adic cohomology of Rapoport-Zink spaces can be precisely decribed by means of the local Langlands correspondence for general reductive groups. In this talk, I will give results on relationship between the ℓ-adic cohomology of Rapoport-Zink spaces and the Zelevinsky involution. I will also explain some applications to compute the ℓ-adic cohomology.

Geometrizing characters of tori

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The passage from functions to sheaves has proven a valuable tool in the geometric Langlands program. In this talk I'll describe a "geometric avatar" for the group of characters of $T(K)$, where T is an algebraic torus over a local field K. I will then give some potential applications to the classical Langlands correspondence. This is joint work with Clifton Cunningham.

Twisted Bhargava cubes

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Let G be a reductive group and $P = MN$ a maximal parabolic subgroup. The group M acts, by conjugation, on $N/[N, N]$. It is well known that, over an algebraically closed field, the group M acts transitively on a Zariski open set. However, over a general field, the structure of orbits may be quite non-trivial. A description my involve unexpected invariants. A notable example is when G is a split, simply connected group of type D_4, and P is the maximal parabolic corresponding to the branching point of the Dynkin diagram. The space $N/[N, N]$ is also known as the Bhargava cube, and it was the starting point of his investigations of prehomogeneous spaces. We consider a version of this problem for the triality D_4. This is a joint work with Wee Teck Gan.

Stability and sign changes in p-adic harmonic analysis

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Reeder has described a conjectural candidate for the partition of certain supercuspidal representations constructed by Yu (the so called toral, unramified supercuspidals) into L-packets, and verified that it satisfies most of the necessary properties. However, the problem of stability of the appropriate character sums remained outstanding. In this talk, I will discuss joint work with DeBacker that shows the necessary stability. A key ingredient is the study of a sign associated to combinatorial data involving Galois orbits on a root system, which we compute unconditionally in the unramified case.

Conservation relations for local theta correspondence

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I will introduce Kudla-Rallis conjecture on first occurrences of local theta correspondence, and explain the idea of its proof. This is a report of a joint work with Chen-Bo Zhu.

L-functions and theta correspondence

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The doubling method of Piatetski-Shapiro and Rallis applies in the local situation to define local factors of representations of classical groups. On the one hand, the L-factor is defined as a g.c.d. of the local zeta integrals for all good sections. On the other hand, it is defined from the gamma factor by using the Langlands classification. In this talk I develop a theory of the zeta integral and prove that the two candidates of the L-factor agree. Applications include a characterization of nonvanishing of global theta liftings in terms of the analytic properties of the complete L-functions and the occurrence in the local theta correspondence.

Special Session 16
Operator Algebras and Harmonic Analysis

Uncertainty principles for infinite abelian groups

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In this paper, we shall revisit uncertainty principle on finite abelian groups and determine the functions that give Tao's lower bound in above inequality. Our main focus then moves to the additive integer group $\mathbb{Z}$. Its dual is identified with $\mathbb{R}/\mathbb{Z}$ ($= [0, 1)$). Since there is no countably additive invariant (probability) measure on $\mathbb{Z}$, we shall use von Neumann's invariant mean which is a finitely additive for any disjoint subsets. With respect to a given mean on $\mathbb{Z}$ and Lebesgue measure on $\mathbb{R}/\mathbb{Z}$, we show that there is a subset S of $\mathbb{Z}$ with mean 1 so that any square summable functions f supported on S have "full" supported Fourier transform in the sense that the closure of $\text{supp}(f)$ is equal to $[0, 1]$. Symmetrical, we show that there is subset G of $\mathbb{Z}$ with mean 0 so that, for any $x \in [0, 1]$ and any $\epsilon > 0$, all functions supported on G together with those f with $\text{supp}(\hat{f}) \subset [x, x + \epsilon]$ span a dense subset of $l^2(\mathbb{Z})$, the Hilbert space of all square summable functions.

Operator theoretic analogue for Lehmer's problem

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In this talk, we will establish a fascinating connection between Lehmer's problem and operator theory. This is a joint work with Jiayang Yu.

Convolution algebras associated with locally compact quantum groups

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We consider the convolution algebras $L_1(\mathbf{G})$ and $T(L_2(\mathbf{G}))$ associated with a locally compact quantum group $\mathbf{G}$, where $T(L_2(\mathbf{G}))$ is the space of trace class operators on $L_2(\mathbf{G})$ with the convolution induced by the right fundamental unitary of $\mathbf{G}$. We obtain a natural isomorphism between the completely bounded right multiplier algebras of $L_1(\mathbf{G})$ and $T(L_2(\mathbf{G}))$, and characterize the regularity of the quantum group $\mathbf{G}$ in terms of the convolution on $T(L_2(\mathbf{G}))$. We show that $T(L_2(\mathbf{G}))$ is strongly Arens irregular in the sense of Dales and Lau if and only if $\mathbf{G}$ is finite. Some commutation relations of completely bounded multipliers of $L_1(\mathbf{G})$ will also be discussed. This is joint work with Matthias Neufang and Zhong-Jin Ruan.

Complex geometry and similarity of Cowen-Douglas operators

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In this talk, we discuss the similarity invariant of the geometry operator induced by the holomorphic bundle. We give a complete similarity invariant of this kind of geometry operator by using K-group and curvature.

Minimum phase operators and the Polya-Schur problem

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We set a mathematical framework for understanding minimum phase preserving physical processes and obtain the following. The natural analytic setting for these time-limited signals is Hilbert-Hardy space. The minimum phase (or impulsive) signals correspond to the outer functions in Hardy space. The minimum phase preserving processes correspond to linear operators which preserve the set of shifted outer functions.

Our main result shows these linear operators on Hardy space are completely characterized as a combination of a multiplication and a composition operator involving holomorphic functions of a specific form. The proof of this result makes essential use of Hadamard's Theorem and the Weierstrass product representation. Remarkably, this result also extends to provide constructive solutions to the Polya-Schur problem of finding linear operators that preserve the zero-sets of families of complex polynomials. Returning to the physical problem, these processes thus consist of a stationary filtering combined with a frequency-dependent Q-attenuation.

Joint with Peter. C. Gibson and Gary F. Margrave

Kishimoto's conjugacy theorems in simple C^*-algebras of tracial rank one

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Let A be a unital separable simple amenable C*-algebra with finite tracial rank which satisfies the UCT. Suppose α and β are two automorphisms with the Rokhlin property. We show that α and β are strongly co-cycle conjugate and uniformly approximately conjugate, i.e., there exists a sequence of unitaries $\{u_n\} \subset A$ and a sequence of strong asymptotically inner automorphisms σ_n such that

$$\alpha = \mathrm{Ad}\, u_n \circ \sigma_n \circ \beta \circ \beta_n^{-1} \text{ and } \lim_{n\to\infty} \|u_n - 1\| = 0,$$

provided that they induce the same K-theoretical data. We also show that converse also holds. We also give a K-description as exactly when α and β are co-cycle conjugate. We also show that given a K-theoretical data, there is an automorphism α with the Rokhlin property which has that given K-theoretical data.

Spectral gap actions and invariant states

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We define spectral gap actions of discrete groups on von Neumann algebras and study their relations with invariant states. We will show that a finitely generated ICC group Γ is inner amenable if and only if there exist more than one inner invariant states on the group von Neumann algebra $L(\Gamma)$. Moreover, a countable discrete group Γ has property (T) if and only if for any action α of Γ on a von Neumann algebra N, every α-invariant state on N is a weak-*-limit of a net of normal α-invariant states.

Quantum correlations and Tsirelson's problem

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The EPR paradox tells us quantum theory is incompatible with classic realistic theory. Indeed, Bell has shown that quantum correlations of independent bipartite systems have more possibility than the classical correlations. To study what the possibilities are, Tsirelson has introduced the set of quantum correlation matrices, but depending on the interpretation of independence, there are two plausible definitions of it. Tsirelson's problem asks whether these definitions are equivalent. It turned out that this problem in quantum information theory is in fact equivalent to Connes's embedding conjecture, one of the most important open problems in theory of operator algebras. I will talk some recent progress on Tsirelson's problem.

Ergodic theory over locally compact quantum groups

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We develop the elements of an ergodic theory over locally compact quantum (semi)groups and extend results by Zsidó *et al.*. This is joint work with Ami Viselter.

Extending derivations to dual Banach algebras

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If $D : A \to X$ is a derivation from a Banach algebra to a contractive, Banach A-bimodule, then one can equip X^{**} with an A^{**}-bimodule structure, such that the second transpose $D^{**} : A^{**} \to X^{**}$ is again a derivation. I present an analogous extension result, where A^{**} is replaced by the enveloping dual Banach algebra $\mathsf{F}(A)$ (as introduced by V. Runde), and X^{**} by an appropriate kind of universal, enveloping, normal dual bimodule of X. Our approach is motivated by earlier results of F. Gourdeau.

I apply these constructions to obtain some new characterizations of Connes-amenability of $\mathsf{F}(A)$. In particular, we show that $\mathsf{F}(A)$ is Connes-amenablity if and only if A admits a so-called WAP-virtual diagonal. Also, in the case where $A = L^1(G)$, we show by modifying arguments of Runde that existence of a WAP-virtual diagonal is equivalent to the existence of a virtual diagonal in the usual sense. Our approach does not involve invariant means for G.

p-variations of Fourier algebras

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Let G be a compact group and $A(G)$ its Fourier algebra. About a half decade ago, an invesitgation of B. Forrest, E. Samei and the speaker brought up a curious Banach algebra $A_\Delta(G)$ which plays a role relative to operator amenability problems for $A(G)$, in the same manner as a certain algebra $A_\gamma(G)$ of B. Johnson plays to amenability problems. The algebra $A_\gamma(G)$ may be understood as a type of "Beurling-Fourier algebra" on G, in a manner which has been recently invesigated by H.H. Lee, E. Samei, J. Ludwig, L. Turowska and the speaker, in various articles.

I will present a context in which we may understand $A_\Delta(G)$ as the case $p = 2$ in a class of Banach algebras $A^p(G)$ $(1 \leq p \leq \infty)$. Here $A^1(G) = A(G)$, but the rest of the algebras may be understood via interpolation. These algebras do not exhibit the same functorial properties as Fourier algebras, and hence allow us to exhibit some unusual Banach algebras on tori.

This talk represents joint work with H.H. Lee and E. Samei.

Zero products and norm preserving orthogonally additive homogeneous polynomials on C*-algebras

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Let $P : A \to B$ be a bounded orthogonally additive and zero product preserving n-homogeneous polynomial between C*-algebras. We show that, in the commutative case that $A = C_0(X)$ and $B = C_0(Y)$, there exist a bounded continuous function h in $C(Y)$ and a map $\varphi : Y \to X$ such that $Pf = h \cdot (f \circ \varphi)^n$. In the general case, we show that there is a central invertible multiplier h of B and a surjective Jordan homomorphism $J : A \to B$ such that $Pa = hJ(a)^n$, provided that $P(A) \supseteq B^+$. Similar Banach-Stone type theorems also hold for orthogonally additive n-homogeneous polynomials which are n-isometries. Using these results, we provide the full structure of orthogonally additive and orthogonally multiplicative holomorphic functions on commutative C*-algebras.

This is a joint work with Qingying Bu (Univ. of Mississippi) and Ming-Hsiu Hsu (Nat'l Sun Yat-sen Univ.)

Recent development of analysis on noncommutative tori

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Noncommutative tori are fundamental examples in operator algebras and noncommutative geometry. This talk will present a survey on the recent development of analysis on noncommutative tori. The results presented will include those on harmonic analysis and Sobolev embedding inequalities on quantum tori. This talk is based on joint works with Zeqian Chen, Xiao Xiong and Zhi Yin.

Amenability properties of weighted group algebras

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Let G be a locally compact group and ω a continuous weight on G. It is well-known that the weighted group algebra $L^1(G,\omega)$ is amenable as a Banach algebra if and only if G is an amenable group and the function $\Omega(t) = \omega(t)\omega(t^{-1})$ is bounded on G. We show that, for an abelian locally compact group G, $L^1(G,\omega)$ is weakly amenable if and only if there is no nontrivial continuous group homomorphism ϕ: $G \to (\mathbb{C}, +)$ such that

$$\sup_{t\in G} \frac{|\phi(t)|}{\Omega(t)} < \infty.$$

In other words, $\Omega(t)$ shall grow slower then any ϕ in order $L^1(G,\omega)$ to be weakly amenable.

We will also consider the weak amenability of $L^1(G,\omega)$ and its center $ZL^1(G,\omega)$ for non-commutative locally compact groups G, discussing some special cases. In general, how to characterize the weak amenability of a non-commutative $L^1(G,\omega)$ and how to characterize the weak amenability of its center algebra are still open problems.

Special Session 17
Optimization

Regularized interior proximal alternating directions method

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We consider convex constrained optimization problems with a special separable structure. We propose a class of alternating directions methods (ADM) where their subproblems are regularized with a general interior proximal metric which covers the double regularization proposed by Silva and Eckstein. Under standard assumptions, global convergence of the primal-dual sequences produced by the algorithm is established.

Linear conic programming and interior-point algorithms

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Linear conic programming extends the popularly used linear programming models from linearity to non-linearity as well as from convexity to non-convexity in polynomial-time computations. Linear conic programming problems are linear programming models with the additional constraint of products of nonlinear cones which include two classes of important cones. One class is symmetric cone which leads to symmetric cone optimization problems such as linear, semideąĕnite and second-order cone programming problems in which the cone constraints are self-dual and homogeneous. These symmetric conic programming can be solved eąÀciently using polynomial-time interior-point methods. Another class is nonsymmetric cone optimization problems such as copositive cone programming problems and the cone programming of nonnegative quadratic function over a set. For these conic programming the cone constraints are not self-dual and in particular requires special purpose algorithm. The purpose of this talk is to introduce a very rich formulation of linear conic programming and present the general model, the conjugate duality theory, path-following interior point approaches and illustrative applications of linear conic programming.

Design of robust truss structures for minimum weight using the sequential convex approximation method

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Trusses are mechanical structures in R^{d}, where d is 2 for planar trusses or 3 for three-dimensional ones. They consist of an ensemble of N nodes joint by $m \geq 2$ bars which are made of a linear elastic, isotropic and homogeneous material. Long bars overlapping small ones are not allowed, and therefore $m \leq N(N-1)/2$ for a mesh full of bars. Trusses are designed to support some external nodal loads taking into account the properties of the bar material. We assume that there exists a set of primary external loads, applied only in the nodes of the truss, and that there exists a set of secondary nodal ones that are uncertain in size and direction, which can be viewed as a perturbation of the main loads. Our main objective is to minimize the total amount of material or weight, with the purpose of finding the most *economic* structure, that is robust under load perturbations.

We formulate a model in order to include the mechanical equilibrium constraint and stress constraints, as well as bounds on displacements, considering also stability constraints under perturbation of the main load. More precisely, we will study the properties of the following non–convex semi-infinite mathematical programming problem

$$
\begin{aligned}
(P_w)\min_{x\geq 0} \quad & \sum_{i=1}^{m} x_i \\
& |u_j(\xi,x)| \leq \bar{u}_j \; j \in J \subseteq \{1,\ldots,n\}, \\
& |\sigma_i(\xi,x)| \leq \bar{\sigma}_i \; i \in I \subseteq \{1,\ldots,m\}, \\
& \xi \in E,
\end{aligned}
$$

where x_i represents the volume of each bar, u is the vector of displacements, and σ_i the stress of the i-th bar. The set $E \subseteq \mathrm{R}^{\mathrm{n}}$ corresponds to the set of secondary loads, and we implicitly assume the mechanical equilibrium constraint $K(x)u(\xi,x) = f + \xi$. To address the infinite number of constraints we reformulate (P_w) as a non–convex bilevel mathematical program. The main idea is to solve this problem assuming that the set E of secondary loads takes the form of a particular ellipsoid, similar to the approached by Ben-Tal and Nemirovski . Based on the work of Beck et al., we have obtained encouraging preliminary numerical results for this alternative, which approach consists on approximating some non–convex constraints and solving a sequence of parametric conic problems.

Expected residual minimization for stochastic variational inequalities

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This talk discusses a variety of computational approaches for stochastic variational inequalities and presents a new expected residual minimization formulation for a class of stochastic variational inequalities by using the gap function. The objective function of the expected residual minimization problem is nonnegative and Lipschitz continuous. Moreover, it is convex for some stochastic linear variational inequalities, which helps us guarantee the existence of a solution and convergence of approximation methods. We propose a globally convergent (a.s.) smoothing sample average approximation (SSAA) method to minimize the expected residual function. We show that the residual minimization problem and its SSAA problems have minimizers in a compact set and any cluster point of minimizers and stationary points of the SSAA problems is a minimizer and a stationary point of the expected residual minimization problem (a.s.). Our examples come from applications involving traffic flow problems. We show that the conditions we impose are satisfied and that the solutions, efficiently generated by the SSAA procedure, have desirable properties.

Joint work with Roger Wets and Yangfan Zhang.

Stability of two-stage stochastic programs with quadratic continuous recourse

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We consider the stability of the two-stage quadratic stochastic programming problem with quadratic continuous recourse when the underlying probability distribution is perturbed. For the case that all the coefficients in the objective function and the right-hand side vector in second-stage constraints are random, we firstly show the locally Lipschtiz continuity of the optimal value function of the recourse problem; then under suitable probability metric, we derive the Lipschitz continuity of the expected optimal value function with respect to the first-stage variable and the probability distribution; and furthermore, we establish the qualitative and quantitative stability results of the optimal value function and the optimal solution set with respect to the Fortet-Mourier probability metric. For the more complex situation that the recourse costs, the recourse matrix, the technology matrix and the right-hand side vector in the second-stage problem are all random, and that the second-stage objective function might be non-convex, we obtain the uniformly boundedness and locally Lipschtiz continuity of the second-stage feasible solution set when it is regular and bounded; we also establish the locally Lipschtiz continuity of the corresponding optimal value function; then we show the Lipschitz continuity of the expected value function of the second-stage problem with respect to both the first-stage variables and the probability metric involved in the second-stage problem; utilizing these results, we finally derive the qualitative and quantitative stability results of the optimal value function and the optimal solution set of two-stage quadratic stochastic programs with respect to the Fortet-Mourier probability metric.

Existence of minimizers on drops

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For a boundedly generated drop $[a, E]$ (property which holds, for instance, whenever E is bounded), where a belongs to a real Banach space X and $E \subset X$ is a nonempty convex set, we show that for every lower semicontinuous function $h : X \longrightarrow \mathbb{R} \cup \{+\infty\}$ that satisfies $\sup_{\delta} > 0_x^{inf} \in E + \delta Bx^{h(x)} > h(a)(B_X$ being the unitary open ball in X), there exists $\overline{x} \in [a, E]$ such that $h(a) \geq h(\overline{x})$ and $\overline{x}$ is a strict minimizer of h on the drop $[\overline{x}, E]$.

The robust stability of every equilibrium in economic models of exchange

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In an economic model of exchange of goods, the structure can be specified by utility functions. Under utility conditions identified here even more broadly than usual, except for concavity in place of quasi-concavity, every equilibrium will simultaneously be stable with respect to shifts in the associated holdings of the agents and with respect to the dynamic Walrasian tatonnement process of price adjustment. This fact, seemingly contrary to widespread belief, is revealed by paying close attention not only to prices but also to the proximal status of initial holdings.

The conditions on the concave utility functions are standard for stability investigations, in that they invoke properties coming from second derivatives, but significantly relaxed in not forcing all goods to be held only in positive amounts. Recent advances in variational analysis provide the support needed for working in that context.

The stability results also point the way toward further developments in which an equilibrium might evolve in response to exogenous inputs to the agents' holdings, or extractions.

Solving mathematical programs with equilibrium constraints as constrained equations

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This paper aims at developing effective numerical methods for solving mathematical programs with equilibrium constraints. Due to the complementarity constraints, the usual constraint qualifications such as the Mangasarian-Fromovitz constraint qualification do not hold at any feasible point and there are various stationarity concepts such as Clarke/Mordukhovich/strong stationarity suggested in the literature. In this paper, we reformulate these stationarity conditions as smooth equations with box constraints. We then present a modified Levenberg-Marquardt method for solving these constrained equations. We show that, under some weak local error bound conditions, the method is locally and superlinearly convergent. Furthermore, we give some sufficient conditions for local error bounds to hold and show that these conditions are not very stringent by a number of examples.

A feasible direction algorithm for nonlinear second-order cone optimization problems

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In this work, we propose a feasible direction algorithm for solving nonlinear convex second-order cone programs. This kind of problems consists of minimizing a convex function over the Cartesian product of second-order cones. Our approach computes feasible descend directions by using the same formulation as in FDIPA proposed by Herskovitz [*J. Optim. Theory Appl.*, vol. 99 (1998), pp. 53–58]. Under suitable assumptions, some results preliminaries of convergence are obtained. Finally, to show how our algorithm works in practice, computational results applied to support vector machines under uncertainty is presented.

A dynamical approach to an inertial forward-backward algorithm for convex minimization

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We introduce a new class of forward-backward algorithms for structured convex minimization problems in Hilbert spaces. Our approach relies on the time discretization of a second-order differential system with two potentials and Hessian-driven damping. This system can be equivalently written as a first order-system in time and space, each of the two constitutive equations involving only one of the two potentials. Its time dicretization naturally leads to the introduction of forward-backward splitting algorithms with inertial features. Using a Liapunov analysis, we show the convergence of the algorithm under conditions improving the classical step size limitation. Then, we specialize our results to gradient-projection algorithms, and give some illustration to sparse signal recovery and feasibility problems.

Second-order analysis in conic programming: Applications to stability

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In this talk we review some recent results obtained for conic programs from the application of a second-order generalized differential approach. It is used to calculate appropriate derivatives and coderivatives of the corresponding solution maps. These developments allow us to obtain verifiable conditions for the strong regularity, the Aubin property and isolated calmness of the considered solution maps. The main results obtained in the general conic programming setting are specified for and illustrated by the second-order cone programming

[1] J. F. Bonnans and H. Ramírez C., *Perturbation analysis of second-order cone programming problems.* Math. Program., 104 (2005), pp. 205-227.
[2] J. V. Outrata and H. Ramírez C., *On the Aubin property of critical points to perturbed second-order cone programs*, SIAM J. Optim., 21 (2011), pp. 798-823.
[3] B. Mordukhovich, J. V. Outrata and H. Ramírez C., *Second-order variational analysis in conic programming with application to optimality and stability*. Submitted (2013).

Facially exposed cones are not always nice

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We show that Gabor Pataki's conjecture that facially exposed cones are nice is true in three-dimensional case, but does not hold for higher dimensions by presenting a four-dimensional counterexample. We also discuss implications of this result and state some open problems.

Asymptotic convergence analysis for distributional robust optimization and equilibrium problems

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In this paper, we study distributional robust optimization approaches for a one stage stochastic minimization problem, where the true distribution of the underlying random variables is unknown but it is possible to construct a set of probability distributions which contains the true distribution and optimal decision is taken on the basis of worst possible distribution from that set. We consider the case when the distributional set is constructed through

samples and investigate asymptotic convergence of optimal values and optimal solutions as sample size increases. The analysis provides a unified framework for asymptotic convergence of some data-driven problems and extends the classical asymptotic convergence analysis in stochastic programming. The discussion is extended to a stochastic Nash equilibrium problem where each player takes a robust action on the basis of their subjective expected objective value.

Special Session 18
Probability

The motion of a tagged particle in the simple exclusion process

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The simple exclusion process is an interacting particle system. There is no birth or death of particles. Each particle perform an independent random walk. The walk is suspended when a particle jumps to the site of another particle. Therefore a tagged particle behaviors very much like a random walk with a fixed rate of slow down. In this talk we shall review some limit theorems of a tagged particle in the simple exclusion and report our progress in this direction.

Multivariate normal approximation by Stein's method: the concentration inequality approach

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In this talk we will describe Stein's method for normal approximation and explain the role of concentration inequalities in proving Kolmogorov bounds in one dimension. We will then discuss multivariate extensions of both the normal approximation and the concentration inequalities. The multivariate concentration inequalities are then applied to multivariate normal approximation for independent summands as well as for locally dependent summands. This talk is based on joint work with Xiao Fang.

Stable processes with drift

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Suppose that $d \geq 1$ and $\alpha \in (1, 2)$. Let Y be a rotationally symmetric α-stable process on $\mathbf{R}^d$ and b an $\mathbf{R}^d$-valued measurable function on $\mathbf{R}^d$ belonging to a certain Kato class of Y. We show that $dX_t = dY_t + b(X_t)dt$ with $X_0 = x$ has a unique weak solution for every $x \in \mathbf{R}^d$. Let $\mathcal{L}^b = -(-\Delta)^{\alpha/2} + b \cdot \nabla$, which is the infinitesimal generator of X^b. Denote by $C_c^\infty(\mathbf{R}^d)$ the space of smooth functions on $\mathbf{R}^d$ with compact support. We further show that the martingale problem for $(\mathcal{L}^b, C_c^\infty(\mathbf{R}^d))$ has a unique solution for each initial value $x \in \mathbf{R}^d$. Moreover, sharp two-sided estimates for the transition density function of X can be obtained as well as that of its subprocess killed upon leaving a C^2-smooth open set. This talk is based on a joint work with Longmin Wang.

Brownian motion in a heavy tailed Poissonian potential

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Consider the d-dimensional Brownian motion in a random potential defined by attaching a non-negative and polynomially decaying potential around Poisson points. We introduce a repulsive interaction between the Brownian path and the Poisson points by weighting the measure by the Feynman-Kac functional. Under the (annealed) weighted measure, it is shown that the Brownian motion tends to localize around the origin and the properly scaled process converges in law to a Ornstein-Uhlenbeck process.

Martingale problem under non-linear expectations

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We consider the martingale problem under the framework of nonlinear expectations, analogous to that in a probability space in the seminal paper of Stroock and Varadhan (1969).

We first establish an appropriate comparison theorem and the existence result for the associated state-dependent fully non-linear parabolic PDEs. We then construct the conditional expectation from the viscosity solution of the PDEs, and solve the existence of martingale problems. Under this non-linear expectation space, we further develop the stochastic integral and the Itô's type formula, which are consistent with Peng's G-framework. As an application, we introduce the notion of weak solution of SDE under the non-linear expectation.

Scaling limits of interacting particle systems in high dimensions.

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A number of (interacting) particle systems at criticality, such as the voter model, the contact process, oriented percolation, and lattice trees, have been conjectured or proved to behave like the critial branching random walk, when the dimension is high enough so that the interaction is weak. One version of this statement is that appropriately rescaled versions of these models converge to super-Brownian motion. We will discuss what is known and not known about these models in the context of convergence to super-Brownian motion.

Parabolic Littlewood-Paley inequality for $\phi(-\Delta)$-type operators and applications to stochastic integro-differential equations

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In this talk we introduce a parabolic version of the Littlewood-Paley inequality for the operators of the type $\phi(-\Delta)$, where ϕ is a Bernstein function. As an application, we construct an L_p-theory for the stochastic integro-differential equations of the type $du = (-\phi(-\Delta)u+f)\,dt+ g\,dW_t$. This is a joint work with Ildoo Kim and Kyeong-Hun Kim.

Quenched invariance principles for random walks and random divergence forms in random media with a boundary

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We will consider the following two models and establish quenched invariance principles;

1. Simple random walks on the infinite clusters for supercritical percolations on half and quarter planes in d-dimensional Euclidean spaces.

2. Uniform elliptic divergence forms with random stationary coefficients on cones in Euclidean spaces.

Note that because of the lack of translation invariance we cannot apply the method of the 'corrector'. ÂăInstead we make full use of the heat kernel estimates and Dirichlet form techniques to resolve the problem. This is a joint work with Z.Q. Chen (Seattle) and D.A. Croydon (Warwick).

Ultrametric potentials

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In matrix theory an important question is the so called inverse M-matrix problem. Recall that an M-matrix is a nonsingular matrix whose off diagonal elements are non-positive and whose inverse is non-negative. So, the question is which nonnegative matrices are inverses of M-matrices?.

The inverse of an M-matrix is naturally linked to the potential of a transient Markov chain and then one can use a Theorem of Choquet-Deny to characterize these matrices. The main drawback of this result is that the characterization is difficult to check for a given matrix.

We connect this problem with the notion of ultrametric matrices and filtered matrices. Using these concepts we provide a large class of inverse M-matrices that are described in combinatorial terms. Special attention is given to one dimensional random walks and random walks on trees. We also discuss extensions to diffusions.

Some of the useful bibliography is given below.

[1] C. Dellacherie, S. Martínez and J. San Martín, Ultrametric matrices and induced Markov chains. *Advances in Applied Mathematics,* **17** (1996), 169–183.

[2] C. Dellacherie, S. Martínez and J. San Martín, Description of the Sub-Markov kernel associated to generalized ultrametric matrices. An algorithmic approach. *Linear Algebra and its Applications,* **318** (2000), 1-21.

[3] C. Dellacherie, S. Martínez, J. San Martín, Hadamard functions of inverse M-Matrices. SIAM Journal on Matrix Analysis and Applications (2009) 31, 2, 289–315.

[4] C. Dellacherie, S. Martínez S., J. San Martín, Ultrametric and tree potential. Journal of Theoretical Probability (2009) 22, 2, 311–347.

[5] F.R. Gantmacher and M.G. Krein, Oszillationsmatrizen, Oszillationskerne und kleine Schwingungen mechanischer Systeme, (1960) Akademie-Verlag, Berlin.

[6] T.L. Markham, Nonnegative matrices whose inverses are M-matrices. *Proceedings of the American Mathematical Society,* **36** (1972), 326–330.

[7] S. Martínez, G. Michon and J. San Martín, Inverses of ultrametric matrices are of Stieltjes types, *SIAM Journal Matrix Analysis and its Applications,* **15** (1994), 98–106.

[8] S. Martínez, J. San Martín, X. Zhang. A new class of inverse M-matrices of tree-like type. *SIAM Journal on Matrix Analysis and Applications,* **24**-4 (2003), 1136–1148.

[9] S. Martínez, J. San Martín, X. Zhang. A class of M-matrices whose graphs are trees. *Linear and Multilinear Algebra* **52**-5 (2004), 303–319.

[10] J.J. McDonald, M. Neumann, H. Schneider, M.J. Tsatsomeros, Inverse M-matrix inequalities and generalized ultrametric matrices. *Linear Algebra and its Applications,* **220** (1995), 321–341.

[11] J.J. McDonald, R. Nabben, M. Neumann,H. Schneider, M.J. Tsatsomeros Inverse tridiagonal Z-matrices. *Linear and Multilinear Algebra* **45** (1998), 75–97.

[12] R. Nabben, On Green's matrices of trees. *SIAM Journal Matrix Analysis and its Applications,* **22**, no. 4, (2001), 1014–1026.

From Stein's method to self-normalized moderate deviations

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In this talk we shall review recent developments on Stein's method and self-normalized limit theory. The focus will be on randomized concentration inequalities and their applications to self-normalized Cramer type moderate theorems.

Backward stochastic differential equations driven by G-Brownian motion

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In this paper, we study the backward stochastic differential equations driven by G-Brownian motion in the following form: $Y_t = \xi + \int_t^T f(s, Y_s, Z_s)ds + \int_t^T g(s, Y_s, Z_s)d\langle B\rangle_s - \int_t^T Z_s dB_s - K_T + K_t$. Under a Lipschitz condition of f and g in Y and Z, the existence and uniqueness of the solution (Y, Z, K) is proved, where K is a decreasing G-martingale.

Symmetric rearrangements around infinity with applications to Lévy processes

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We prove a new rearrangement inequality for multiple integrals, which partly generalizes a result of Friedberg and Luttinger (1976) and can be interpreted as involving symmetric rearrangements of domains around infinity. As applications, we prove two comparison results for general Lévy processes and their symmetric rearrangements. The first application concerns the survival probability of a point particle in a Poisson field of moving traps following independent Lévy motions. We show that the survival probability can only increase if the point particle does not move, and the traps and the Lévy motions are symmetrically rearranged. This essentially generalizes an isoperimetric inequality of Peres and Sousi (2011) for the Wiener sausage. In the second application, we show that the q-capacity of a Borel measurable set for a Lévy process can only increase if the set and the Lévy process are symmetrically rearranged. This result generalizes an inequality obtained by Watanabe (1983) for symmetric Lévy processes. Based on joint work with Alex Drewitz and Perla Sousi.

Bismut formula and gradient estimates for SDEs driven by multiplicative Lévy noise

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Bismut formula and Gradient estimates are derived for the semigroup associated to a class of stochastic differential equations driven by multiplicative Lévy noise, where the noise is realized as a subordination of the Brownian motion. In particular, the estimates are sharp for α-stable type noises. To derive these estimates, a new derivative formula is established for the semigroup by using the Malliavin calculus and a finite-jump approximation argument.

Viscosity solutions of path dependent PDEs

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Path Dependent PDEs (PPDEs, for short) is a convenient tool to characterize the value functions of various types of stochastic control problems in non- Markovian framework. Its typical examples include Backward SDEs (semi- linear PPDEs), second order BSDEs (path dependent HJB equations), path dependent Bellman-Isaacs equations, and Backward Stochastic PDEs. PPDEs can rarely have classical solutions. In this talk we shall propose a notion of viscosity solutions for PPDEs and establish its wellposedness. Our definition relies heavily on the Functional Ito formula initiated by Dupire. Unlike the viscosity theory of standard PDEs, the main difficulty in path dependent case is that the state space is not locally compact. To overcome such difficulty, we replace the pointwise maximization in standard theory with an optimal stopping problem under Peng's nonlinear expectation. The talk will be based on joint works with Nizar Touzi, and Ibrahim Ekren, Christian Keller, Triet Pham.

Special Session 19
Representation Theory and Categorification

Geometric reciprocity for algebraic tori over non-Archimedean local fields

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Recent work with David Roe has shown that the geometrization of admissible characters of $T(K)$, where T is an algebraic torus over a non-Archimedean field K, is achieved by introducing the tensor category of character sheaves on the Greenberg transform of the Neron model of T. On the other hand, earlier worth with Achar, Kamgarpour and Salmasian, closely related to ideas of Vogan, shows that the geometrization of Langlands parameters for T is achieved by passing to the category of equivariant perverse sheaves on an ind-variety formed from ${}^LT$. In this talk I will use the class field theory of Serre and Hazewinkel to relate these two categories.

Schubert calculus and cohomology of Lie groups

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The problem of determining the cohomology of Lie groups was raised by E. Cartan in 1929, and has been a focus of algebraic topology for the fundamental roles of Lie groups playing in geometry and topology. On the other hand Schubert calculus begun with the intersection theory of the 19 century, and clarifying this calculus had been a major theme of the 20 century algebraic geometry.

We bring a connection between these two topics both with distinguished historical backgrounds, and demonstrate how Schubert calculus is extended as to give an explicit and unified construction of the integral cohomology rings of all compact and 1-connected Lie groups.

Vanishing properties of Jack polynomials

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(Joint work with Christine Berkesch and Steven Sam)

We describe some interactions between representations of rational Cherednik algebra, especially unitary representations, and questions arising in combinatorial commutative algebra and mathematical physics. These questions all have to do with highly symmetric linear subspace arrangements and the ideals of polynomials vanishing on them. Among other things, we will indicate how to use representation theory to prove a number of conjectures of Bernevig and Haldane on the order of vanishing of certain Jack polynomials along these arrangements, and present our own conjecture describing a Bernstein-Gelfand-Gelfand type resolutions of unitary representations of the Cherednik algebra. Any such resolution is automatically a minimal free resolution for the ideal of the corresponding linear arrangement, so we predict a combiantorial formula for the graded equivariant Betti numbers of these ideals.

The modular generalized Springer correspondence

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Given a connected reductive algebraic group G with Weyl group W, the Springer correspondence realizes the category of representations of W as a quotient of the category of G-equivariant perverse sheaves on the nilpotent cone. In the original definition, the representations and sheaves were over a field of characteristic zero, but we have recently shown that the same formalism works with modular coefficients, where the categories are no longer semisimple. In the characteristic-zero case, Lusztig defined a generalized Springer correspondence to interpret the whole category of G-equivariant perverse sheaves on the nilpotent cone in terms of representations of relative Weyl groups. We define and determine a modular generalized Springer correspondence in the case $G = \mathrm{GL}(n)$. This gives a geometric explanation for the fact that, in the modular case, the category of modules over the Schur algebra can be obtained by successive recollements of categories of representations of suitable products of symmetric groups.

Knot invariants and their categorifications via Howe duality

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It is a well understood story that one can extract link invariants associated to simple Lie algebras. These invariants are called Reshetikhin-Turaev invariants and the famous Jones polynomial is the simplest example. Kauffman showed that the Jones polynomial could be described very simply by replacing crossings in a knot diagram by various smoothings. In this talk we will explain Cautis-Kamnitzer-Licata's simple new approach to understanding these invariants using basic representation theory and the quantum Weyl group action. Their approach is based on a version of Howe duality for exterior algebras called skew-Howe duality. Even the graphical (or skein theory) description of these invariants can be recovered in an elementary way from this data. The advantage of this approach is that it suggests a 'categorification' where knot homology theories arise in an elementary way from higher representation theory and the structure of categorified quantum groups.

Center at the critical level and commutative subalgebras

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For each simple Lie algebra g the vacuum module over the corresponding affine Kac-Moody algebra has a vertex algebra structure. For each Lie algebra g of classical type, we use explicit generators of the center of this vertex algebra to produce explicit constructions of maximal commutative subalgebras of the universal enveloping algebras U(g).

Cluster algebras and singular supports of perverse sheaves

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We propose an approach to Geiss-Leclerc-Schroer's conjecture on the cluster algebra structure on the coordinate ring of a unipotent subgroup and the dual canonical base. It is based on singular supports of perverse sheaves on the space of representations of a quiver, which give the canonical base.

On orbits in double flag varieties for symmetric pairs

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Let G be a connected, simply connected semisimple algebraic group over the complex number field, and let K be the fixed point subgroup of an involutive automorphism of G so that (G, K) is a symmetric pair. We take parabolic subgroups P of G and Q of K respectively and consider the product of partial flag varieties G/P and K/Q with diagonal K-action, which we call a double flag variety for a symmetric pair. It is said to be of finite type if there are only finitely many K-orbits on it. In this paper, we give a parameterization of K-orbits on $G/P \times K/Q$ in terms of quotient spaces of unipotent groups without assuming the finiteness of orbits. As a result, we get several useful criteria for the finiteness of orbits. If one of $P \subset G$ or $Q \subset K$ is a Borel subgroup, the finiteness of orbits is closely related to spherical actions. In such cases, the criteria enable us to obtain a complete classification of double flag varieties of finite type. As a consequence, we obtain classifications of K-spherical flag varieties G/P and G-spherical homogeneous spaces G/Q.

Elementary subalgebras of modular Lie algebras

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Let $\mathfrak{g}$ be a p-Lie algebra. We call a subalgebra $\mathfrak{E}$ of $\mathfrak{g}$ *elementary* of rank r if it is an abelian Lie algebra with trivial p-restriction of dimension r. For a fixed r we consider a projective variety $\mathbb{E}(r, \mathfrak{g})$ that parameterizes all elementary subalgebras of $\mathfrak{g}$ of rank r. This variety is a natural generalization of the rank variety introduced by Carlson for elementary abelian p-groups and the support variety for Lie algebras of Friedlander and Parshall.

We'll identify this projective variety in various classical cases. We'll also show how representations of $\mathfrak{g}$ with special properties lead to constructions of families of vector bundles on $\mathbb{E}(r, g)$, thereby extending the study of "modules of constant Jordan type" and their geometric applications to this more general context.

Support varieties for reductive groups

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Let G be a reductive algebraic group over an algebraically closed field of characteristic p, and denote by $G_{(r)}$ its r-th Frobenius kernel. Each $G_{(r)}$-module M has associated to it a cohomological support variety, which can be shown in most cases to be homeomorphic to a closed subset of the variety of commuting r-tuples of p-nilpotent elements in the Lie algebra of G. We will give some of the details about this homeomorphism, and also discuss explicit computations in the case that M is the restriction of either a simple G-module or a Weyl module.

Decomposition numbers for the symmetric groups and Schur algebras

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The complete determination of the decomposition numbers for the symmetric groups and Schur algebras in positive characteristic p is a famous open problem; a complete solution of which does not seem to be forthcoming in the near future. In this talk, we present our recent results which provide closed formulas for the decomposition number $d_{\lambda\mu}$ when the partition λ is obtained from μ by moving some nodes whose p-residues are pairwise non-adjacent.

Hodge theory and representation theory

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I will explain how Hodge theory can be used in the representation theory of real groups to attack the problem of the unitary dual.

Globalizing crystal basis for quantum superalgebras

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Canonical basis (or global crystal basis) for quantum groups and their integrable modules was introduced and developed by Lusztig and subsequently by Kashiwara. We will present a construction for the first time, motivated by categorification, of canonical basis for a class of quantum superalgebras and their integrable modules. This is joint work with Sean Clark and David Hill.

Special Session 20
Singularities in Geometry and Topology

The topology of real suspension singularities of type $f\bar{g} + z^n$

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In this talk we present some results on the topology of the family of real analytic germs $F : (\mathbb{C}^3, 0) \to (\mathbb{C}, 0)$ with isolated critical point at 0, given by $F(x, y, z) = f(x, y)\overline{g(x, y)} + z^r$, where f and g are holomorphic,$r \in \mathbb{Z}+$

and $r \geq 2$. We describe the link L_F as a graph manifold using its natural open book decomposition, related to the Milnor fibration of the map-germ $f\bar{g}$ and the description of its monodromy as a quasi-periodic diffeomorphism through its Nielsen invariants. Furthermore, such a germ F gives rise to a Milnor fibration $\frac{F}{|F|} : \mathbb{S}^5 \backslash L_F \to \mathbb{S}^1$. We present a join theorem, which allows us to describe the homotopy type of the Milnor fibration of F and we show some cases where the open book decomposition of $\mathbb{S}^5$ given by the Milnor fibration of F cannot come from the Milnor fibration of a complex singularity in $\mathbb{C}^3$.

On Griffiths numbers for higher dimensional isolated singularities

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We will discuss some numerical invariants for isolated singularities and their relations. In particular, we will show that S. Yau's conjecture on inequalities for $(n-1)$-th Griffiths number and $(n-1)$-th Hironaka number holds for irregular singularities and it is not true in general.

Equisingularity and integral closure of ideals and modules: two partners in a dance

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A family of sets or mappings is equisingular if the singularities of the family are similar, in a well defined sense depending on the equisingularity condition. The theory of integral closure is an important tool for studying equisingularity conditions. It provides invariants which describe the condition, and provide means of proving the conditions hold for a family. In this talk we will quickly reprise results for Whitney equisingularity, then discuss how to apply the same ideas to construct an infinitesimal theory of bi-Lipschitz equivalence.

Improved bounds on the ranks of the Milnor fiber cohomology

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As we showed 25 years ago, the Lê numbers provide upper bounds on the ranks of the cohomology of the Milnor fiber of a function with a critical locus of arbitrary dimension. Our new results deal with when the maps in the Lê complex can be zero, and so give us improved bounds on the Milnor fiber cohomology. Our results in the classical case follow from more general results on the vanishing cycles of perverse sheaves.

Characteristic classes of singular toric varieties

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We discuss the computation of the homology Hirzebruch characteristic classes of (possibly singular) toric varieties. We present two different perspectives for the computation of these characteristic classes. First, we take advantage of the torus-orbit decomposition and the motivic properties of the homology Hirzebruch classes to express the latter in terms of the (dual) Todd classes of closures of orbits. The obtained formula is then applied to weighted lattice point counting in lattice polytopes. Secondly, in the case of simplicial toric varieties, we make use of the Lefschetz-Riemann-Roch theorem in the context of the geometric quotient description of such varieties. In this setting, we define mock Hirzebruch classes of simplicial toric varieties and investigate the difference between the (actual) homology Hirzebruch class and the mock Hirzebruch class. We show that this difference is localized on the singular locus, and we obtain a formula for it in which the contribution of each singular cone is identified explicitly. This is joint work with Jörg Schürmann.

On the topology of real analytic maps

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Joint work with Nivaldo G. Grulha Jr. and José Seade. In this talk we present some recent results on the topology of real analytic maps. Every real analytic map germ $f\colon \mathbb{R}^n \to \mathbb{R}^p$, $p \geq 1$, with arbitrary critical set, has a Milnor-Lê type fibration. Now assume also that f has the Thom a_f-property, and its zero-locus has positive dimension. Also consider another real analytic map germ $g\colon \mathbb{R}^n \to \mathbb{R}^k$ with an isolated critical point at the origin. We have Milnor-Lê type fibrations for f and for $(f, g)\colon \mathbb{R}^n \to \mathbb{R}^{p+k}$, and we prove for these the analogous of the classical Lê-Greuel formula, expressing the difference of the Euler characteristics of the fibers F_f and $F_{f,g}$ in terms of an invariant associated to these maps.

Intersection theory on mixed curves

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We consider two mixed curve $C, C' \subset \mathbb{C}^2$ which are defined by mixed functions of two variables $\mathbf{Z} = (z_1, z_2)$. We have shown in our previu paper that they have canonical orientations. If C and C' are smooth and intersect transversely at P, the intersection number $I_{top}(C, C'; P)$ is topologically defined. We will generalize this definition to the case when the intersection is not necessarily transversal or either C or C' may be singular at P using the defining mixed polynomials.

Newton-Puiseux analysis

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Complex analysis is extended to the Newton-Puiseux field. We give analogues of several clasic results and, as a corollary, a short proof of the Kuo-Lu theorem.

Singularities of several geometric objects related to null curves in Minkowski 3-space

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In this article, we investigate the singularities of null Darboux developables, Gaussian surfaces and pseudo-spherical Darboux Images associated with a null Cartan curve in Minkowski 3−space. This is a joint work with Zhi-Gang Wang.

Broken Lefschetz fibrations and their moves

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A broken Lefschetz fibration (BLF, for short) is a smooth map of a closed oriented 4-manifold onto a closed surface whose singularities consist of Lefschetz critical points (w.r.t. local complex coordinates compatible with the orientations) together with indefinite folds. Such a class of maps was first introduced by Auroux-Donaldson-Katzarkov in relation to near-symplectic structures, and now it is known that every closed oriented 4-manifold admits a BLF over the 2-sphere. In this talk, we give a set of explicit moves for BLFs which can connect any two homotopic BLFs, and give an elementary and constructive proof to the fact that any map into the 2-sphere is homotopic to a BLF whose indefinite fold has embedded image. This is a joint work with R. İnanç Baykur (Max Planck Institute for Mathematics).

Geometry of non-tame polynomial maps

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For a polynomial map $f = (f_1, \ldots, f_k)\colon \mathbf{C}^n \longrightarrow \mathbf{C}^k$ $(1 \leq k \leq n)$, it is well-known that there exists a proper subset $B \subset \mathbf{C}^k$ such that the restriction

$$\mathbf{C}^n \setminus f^{-1}(B) \longrightarrow \mathbf{C}^k \setminus B \tag{5}$$

of f is a locally trivial fibration. We denote by B_f the smallest subset $B \subset \mathbf{C}^k$ satisfying this condition. The elements of B_f are called bifurcation points of f. When $k = 1$ many mathematicians obtained various subsets of $\mathbf{C}^k = \mathbf{C}$ containing B_f. In particular, Némethi and Zaharia [8] showed that for a non-convenient polynomial $f = (f_1)$ such a subset is obtained by the bad faces of its Newton polyhedron at infinity $\Gamma_\infty(f)$. In this talk, we first introduce the following analogue of their result for general $k \geq 1$ (see also Nguyen [9] for a related result).

Theorem: (Chen-Dias-T-Tibăr [2]) Assume that $f = (f_1, \ldots, f_k)\colon \mathbf{C}^n \longrightarrow \mathbf{C}^k$ is non-degenerate at infinity. Let $N_f, K_f \subset \mathbf{C}^k$ be the subsets of $\mathbf{C}^k$ defined by the Newton polyhedra at infinity of $f_1, \ldots, f_k$ in [2]. Then we have

$$B_f \subset f(\mathrm{sing} f) \cup N_f \cup K_f. \tag{6}$$

Note that if $k = 1$ this result coincides with that of [8]. When $k = 1$ and $n = 2$, Némethi and Zaharia [8] proved the equality $B_f = f(\mathrm{sing} f) \cup N_f \cup K_f$ and conjectured its validity also in the higher-dimensional case $n \geq 3$. In this talk, we next introduce our approach to this conjecture. By using the results in [5] we will show that it can be verified in many cases. Finally, we restrict ourselves to the case $k = 1$. If $f = (f_1)$ is convenient and non-degenerate at infinity, then by a result of Broughton [1] we have the cohomological concentration

$$H^j(f^{-1}(R); \mathbf{C}) = 0 \quad (j \neq 0, n-1) \tag{7}$$

for the generic fiber $f^{-1}(R)$ $(R \gg 0)$ of f. However, many polynomials that we usually encounter are not convenient. They are not tame at infinity. The study of non-tame polynomials is important also for the Jacobian conjecture since they are the only interesting objects for it (see [2] etc.). The main reason why non-tame polynomials could not be studied successfully before is that one cannot expect to have the cohomological concentration for them. Here we partially overcome this difficulty on non-tame polynomials by improving the above-mentioned result of Broughton [1] as follows. Let $C_R = \{x \in \mathbf{C} \mid |x| = R\}$ $(R \gg 0)$ be a sufficiently large circle in $\mathbf{C}$ such that $B_f \subset \{x \in \mathbf{C} \mid |x| < R\}$. Then by restricting the locally trivial fibration $\mathbf{C}^n \setminus f^{-1}(B_f) \longrightarrow \mathbf{C} \setminus B_f$ to C_R we obtain a geometric monodromy automorphism $\Phi_f^\infty\colon f^{-1}(R) \simeq f^{-1}(R)$ and the linear maps

$$\Phi_j^\infty\colon H^j(f^{-1}(R); \mathbf{C}) \simeq H^j(f^{-1}(R); \mathbf{C}) \quad (j = 0, 1, \ldots) \tag{8}$$

associated to it. We call Φ_j^∞'s the (cohomological) monodromies at infinity of f. Recently in [10], by using the Newton polyhedron at infinity $\Gamma_\infty(f)$ of f we defined a finite subset $A_f \subset \mathbf{C}$ of "bad" eigenvalues which we call atypical engenvalues of f. Then we have the following refinement of the main result of Broughton [1]. For $\lambda \in \mathbf{C}$ and $j \in \mathbf{Z}$ let $H^j(f^{-1}(R); \mathbf{C})_\lambda \subset H^j(f^{-1}(R); \mathbf{C})$ be the generalized eigenspace for the eigenvalue λ of the monodromy at infinity Φ_j^∞.

Theorem: (T-Tibăr [10]) Let $f \in \mathbf{C}[x_1, \ldots, x_n]$ be a non-convenient polynomial such that $\dim \Gamma_\infty(f) = n$. Assume that f is non-degenerate at infinity. Then for any non-atypical eigenvalue $\lambda \notin A_f$ of f we have the concentration

$$H^j(f^{-1}(R); \mathbf{C})_\lambda \simeq 0 \qquad (j \neq n-1) \tag{9}$$

for the generic fiber $f^{-1}(R) \subset \mathbf{C}^n$ $(R \gg 0)$ of f.

With this theorem at hand, we can extend the results in [4], [6] and [7] etc. to non-convenient polynomials. In particular, as in [7] and [3] by using the motivic Milnor fiber at infinity of f we completely determine the Jordan normal forms of Φ_{n-1}^∞ for non-atypical eigenvalues $\lambda \notin A_f$ of f. See [10] for the details.

[1] Broughton, S. A. "Milnor numbers and the topology of polynomial hypersurfaces", *Invent. Math.*, 92 (1988): 217-241.

[2] Chen, Y., Dias, R., Takeuchi, K. and Tibăr, M. "Invertible polynomial mappings via Newton non-degeneracy", arXiv:1303.6879.

[3] Esterov, A. and Takeuchi, K. "Motivic Milnor fibers over complete intersection varieties and their virtual Betti numbers", *Int. Math. Res. Not.*, Vol. 2012, No. 15 (2012): 3567-3613.

[4] Libgober, A. and Sperber, S. "On the zeta function of monodromy of a polynomial map", *Compositio Math.*, 95 (1995): 287-307.

[5] Matsui, Y. and Takeuchi, K. "Milnor fibers over singular toric varieties and nearby cycle sheaves", *Tohoku Math. J.*, 63 (2011): 113-136.

[6] Matsui, Y. and Takeuchi, K. "Monodromy zeta functions at infinity, Newton polyhedra and constructible sheaves", *Mathematische Zeitschrift*, 268 (2011): 409-439.

[7] Matsui, Y. and Takeuchi, K. "Monodromy at infinity of polynomial maps and Newton polyhedra, with Appendix by C. Sabbah", *Int. Math. Res. Not.*, Vol. 2013, No. 8 (2013): 1691-1746.

[8] Némethi, A. and Zaharia, A. "On the bifurcation set of a polynomial function and Newton boundary", *Publ. Res. Inst. Math. Sci.*, 26 (1990): 681-689.

[9] Nguyen, T. T., "Bifircation set, M-tameness, asymptotic critical values and Newton polyhedrons", arXiv:1205.0939v5, to appear in Kodai Math. J.

[10] Takeuchi, K. and Tibăr, M. "Monodromies at infinity of non-tame polynomials", arXiv:1208.4584.

Characteristic points, fundamental cubic form and Euler characteristic of projective surfaces

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Joint work with M. Kazarian. Generic surfaces in projective 3-space have isolated characteristic points (invariant under projective trasformations and stable under small perturbations of the surface) called elliptic nodes, hyperbolic nodes and godrons (also known as cusps of Gauss). These characteristic points have interesting properties and deserve special attention. We give a geometric definition of the characteristic points (there are several equivalent definitions) and we define natural local invariants for them (a *sign* $\pm$).

Our formulas for global counting of these invariants on the surface (or on domains in it) involve the Euler characteristic of the surface (or of the respective domains) providing restrictions on the coexistence of characteristic points.

One way to prove our counting formulas (we know three ways) is considering the fundamental cubic form: in the same way as the second fundamental quadratic form measures the quadratic deviation of a surface from its tangent plane, the cubic fundamental form measures the cubic deviation of the surface from its quadratic part. The fundamental cubic form is a local intrinsic invariant defined for every point of the surface, which vanish at the characteristic points.

Our exposition will be rather geometrical and for a wide audience.

Topological classification of multiaxial $U(n)$-actions

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A manifold under the action of the unitary group $U(n)$ is multiaxial if all the isotropy groups are unitary subgroups. Such manifolds are often modeled on $k\mathbb{C}^n \oplus j\mathbb{R}$, where $\mathbb{C}^n$ has the canonical $U(n)$-action and $\mathbb{R}$ has trivial $U(n)$-action. One of the major achievements about multiaxial manifolds was M. Davis and W.C. Hsiang's concordance classification in late 1970s for the smooth category and under the assumption $k \leq n$.

We study the structure set $S_{U(n)}(M)$ of a multiaxial $U(n)$-manifold M, which is the homeomorphism classes of the topological $U(n)$-manifolds equivariantly homotopy equivalent to M. We show that $S_{U(n)}(M)$ can be decomposed into simpler structure sets. We discuss the implication of the decomposition and compute explicitly for the case M is the canonical representation sphere. All the results do not assume $k \leq n$.

Milnor fibers of real line arrangements

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The Milnor fiber of a line arrangement is a certain cyclic covering space of the complexified complement equipped with monodromy action. We will discuss the monodromy action on the first homology group. We will present a new algorithm computing multiplicities of monodromy eigenvalues, which uses real and combinatorial structures (chambers). I will also give an upper bounds and several conjectures.

Special Session 21
Symplectic Geometry and Hamiltonian Dynamics

Contacting the moon

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The restricted three body problem has an intriguing dynamics. In joint work with Peter Albers, Gabriel Paternain and Otto van Koert we showed that below and slightly the first critical level energy hypersurfaces of the restricted three body problem are of contact type. This result allows us to apply global methods coming from Gromov-Witten theory, Floer theory, and Symplectic Field theory to this old problem. I will explain how we can use these global methods to detect global surfaces of section were the perturbative methods used so far fail.

Mean Euler characteristic: the degenerate case

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The mean Euler characteristic (MEC) is an invariant of a contact manifold, which is on the one hand sensitive enough to distinguish interesting contact structures and, on the other, relatively easily computable in terms of the dynamics of the Reeb flow. This invariant was introduced by van Koert. As has been shown by Kerman and the speaker, the MEC can be expressed in terms of local, purely topological, invariants of closed Reeb orbits whenever the Reeb flow is non-degenerate and has finitely of such orbits. This expression generalizes the resonance relation for the mean indices of closed characteristics established by Viterbo for convex hypersurfaces, and it has been further refined and generalized by Espina.

In this talk, based on a joint work with Yusuf Goren, we will discuss a version of such a local formula for the MEC when the closed orbits are degenerate. This work builds on the previous results of Long et al. and Hryniewicz and Macarini, and its main new feature is that, as in the non-degenerate case, the contributions of individual orbits are purely topological. We will also touch upon applications of this resonance relation to dynamics.

The Hill-type formula and Krein-type trace formula

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In the study of the motion of lunar perigee, Hill got a formula which relates the characteristic polynomial of the monodromy matrix for a periodic orbit and a kind of infinite determinant. Hill's formula is useful in understanding the property of the monodromy matrix. Motivated by the previous works, we build up the Hill-type formula for S-periodic solutions for first-order ordinary differential equations and Lagrangian systems. The S-periodic solution is a solution such that $x(t) = Sx(t+T)$ for some orthogonal matrix S, which comes naturally from the study of symmetry periodic orbits in n-body problem. Based on it, we get the Trace formula for linear ODE, include the case of standard Sturm-Liouville systems, which can be consider as a generalization of Krein's work in 1950's. Especially, for the eigenvalue problem $Lu + \lambda R(x)u = 0$, where L is the Sturm-Liouville operator, $\sum 1/\lambda_j^k$ can be computed by the trace formula. Some applications for the stability problem is given.

The extremal Kahler metrics on toric manifolds

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We study the prescribed scaler curvature problem on toric manifolds, following Donaldson's program. Let Δ be an open Delzant polytope in $\mathbb{R}^n$ with $\bar{\Delta}$ compact. The prescribed scalar curvature problem reduces then to finding a smooth convex solution in Δ for the 4-th order PDE

$$\sum_{i,j} \frac{\partial^2 u^{ij}}{\partial \xi_i \partial \xi_j} = -A. \tag{10}$$

subjecting to the Guillemin's boundary conditions. This is the Abreu's equation. It is well known that the solution u gives an extremal metric if and only if A is a linear function in Δ.

Denote by $\mathcal{S}$ the set of continuous convex functions u on $\bar{\Delta}$ such that u satisfies the Guillemin's boundary conditions. For a fixed point $p_o \in \Delta$, we set

$$\mathcal{S}_{p_o} = \{u \in \mathcal{S} : u \geq u(p_o) = 0\}.$$

Donaldson introduced a stronger version of stability, which we call the uniform stability. We show that the uniform stability is a necessary condition for existing a smooth solution.

Theorem 1(Bohui Chen, An-Min Li and Li Sheng) If the Abreu equation (1) has a smooth solution in $\mathcal{S}$, then (Δ, A) is uniform stable.

We would suggest a modification on the original conjecture posed by Donaldson:

Conjecture 2 (M, ω) has a metric within the class $[\omega]$ that solves the Abreu equation (1) if and only if (Δ, A) is uniformly K-polystable.

We derived interior estimates for any dimension:

Theorem 3(Bohui Chen, Qing Han, An-Min Li and Li Sheng) Let Δ be a bounded open polytope in $\mathbb{R}^n$ and A be a smooth function on $\bar{\Delta}$. Suppose (Δ, A) is uniformly K-stable and u is a solution in $\mathcal{S}_{p_o}$ of the Abreu's equation (1). Then, for any $\Omega \subset\subset \Delta$, any nonnegative integer k and any constant $\alpha \in (0,1)$,

$$\|u\|_{C^{k+3,\alpha}(\Omega)} \leq C\|A\|_{C^k(\bar{\Delta})},$$

where C is a positive constant depending only on n, k, α, Ω, and λ in the uniform K-stability. For n=2, Donaldson solved the conjecture 2 for $A = constant$, we are able to prove the conjecture 2 for almost any A.

Definition Let A be a smooth function on $\bar{\Delta}$. It is called *edge-nonvanishing* if it does not vanish on any edge of Δ.

Theorem 4(Bohui Chen, An-Min Li and Li Sheng) Let M be a compact toric surface and Δ be its Delzant polytope. Let $A \in C^\infty(\bar{\Delta})$ be an edge-nonvanishing function. If (M, A) is uniformly stable, then there is a smooth T^2-invariant metric on M that solves the Abreu equation.

Canonical connection and analysis of contact Cauchy-Riemann equation

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In this talk, we explain the analysis of the following system of (degenerate) elliptic equation $\overline{\partial}^\pi w = 0$, $d(w^*\lambda \circ j) = 0$ associated for each given contact triad (Q, λ, J) on a contact manifold (Q, ξ), which was first introduced by Hofer. We directly work with this equation on the contact manifolds without involving the symplectization process. We explain the basic analytical ingredients towards the construction of moduli space of solutions, which we call contact instantons. For the needed tensorial calculations, we introduce a canonical affine connection on the contact manifold (Q, ξ), which is associated to each contact triad (Q, λ, J) where λ is a contact form and $J : \xi \to \xi$ is an endomorphism with $J^2 = -id$ compatible to $d\lambda$. We call it the *contact triad connection* of (Q, λ, J) which exists uniquely. This is partially a joint work with Rui Wang.

Anti-symplectic involution and Floer theory

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I will present the work on anti-symplectic involution and its effect on Floer theory for Lagrangian submanifolds based on a joint work with K. Fukaya, Y.-G. Oh and H. Ohta. There are interesting example of Lagrangian submanifolds, which appear as the fixed point set of an anti-symplectic involution. Then we study when they are unobstructed in Floer theoretical sense and its consequences. We can identify the quantum cohomology of (X, ω) and Lagrangian Floer thoery on the diagonal in $(X \times X, -\omega \oplus \omega)$ and define higher operations on quantum cohomology.

Witten equation and the geometry of LG-model

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The study of moduli space of solutions of nonlinear PDE has revolutionized the geometry and topology for last twenty years. The famous examples are Donaldson/Seiberg-Witten theory and Gromov-Witten theory. In the talk, I will discuss another family of PDE introduced by Witten in the context of so called Landau-Ginzburg model. As expected, it is revolutionizing the subject of Landau-Ginzburg model right now.

Isotopy of Lagrangian tori revisited

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Over the last twenty years, isotopy problems of Lagrangian tori (and more generally, Lagrangian submanifolds) have been under investigations from many different approaches. Yet it seems that more can be explored, even for Lagrangian tori in R^4.

In this talk I will review the construction of monodromy groups for Lagrangian submanifolds and report on some recent results concerning the three types (Hamiltonian/Lagrangian/smooth) of monodromy groups Clifford tori and Chekanov tori in R^4.

If time permits, i will also talk about some very recent work in progress on the construction of Lagrangian surfaces via surgery, as well as a potentially new symplectic invariant of Lagrangian surfaces to detect the surgery effect on the Hamiltonian isotopy class of Lagrangian surfaces.

Special Session 22
Symplectic Geometry and Mathematical Physics

A classifying space for commutativity

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Let G denote a Lie group. In this talk we will discuss a classifying space constructed from the commuting elements in G. We compute its cohomology and describe its geometry and homotopy type.

Virtual neighborhood techniques in Gromov-Witten theory

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Abstract: In this talk, I will explain the construction of virtual orbifolds for the moduli spaces of stable curves. In particular, I will explain how to deal with the non-smoothness issues arised from the infinite dimensional set-ups.

Algebra of Legendrian surgery

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I will discuss algebraic structures arising in connection with Legendrian surgery, which enter the computation of holomorphic curve invariants of Weinstein domains and their boundaries. This is a joint work with F. Bourgeois and T. Ekholm.

Fock sheaf of Givental quantization

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I will talk about joint work with Tom Coates (Imperial College London) on a global version of Givental quantization. Based on a generalized variation of Hodge structure (the so-called semi-infinite variation of Hodge structure), we construct a sheaf of Fock spaces which can be identified with Givental's Fock space infinitesimally. An opposite subspace which yields a Frobenius structure on the base plays a role of polarization in the context of geometric quantization. As applications, we discuss modularity of Gromov-Witten potential of local projective plane, and also holomorphic anomaly equation.

Categories and dynamical systems

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In this talk we will discuss recent developments in the theory of stability conditions of categories. We will outline some parallels with classical results from dynamical systems.

Quasimap invariants and mirror maps

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The moduli spaces of stable quasimaps unify various moduli appearing in the study of Gromov-Witten Theory. We introduce big I-functions as the quasimap version of J-functions, generalizing Givental's small I-functions of smooth toric complete intersections. The J-functions are the GW counterparts of periods of mirror families. We discuss some advantages of I-functions, in particular an explanation of mirror maps. This is joint work with I. Ciocan-Fontanine.

The Eynard-Orantin recursion in singularity theory

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It was proved recently that the correlation functions of a semi-simple cohomological field theory satisfy the so called local Eynard–Orantin topological recursion. In my talk, I would like to explain this result in the settings of singularity theory. In my earlier work with B. Bakalov, we have constructed a certain twisted representation of the Heisenberg vertex operator algebra associated with the vanishing cohomology of the singularity. The kernel of the Eynard-Orantin recursion is essentially obtained from the so called operator product expansion of the fields that define the representation. Finally, I would like to report my progress on finding the global recursion, which seems to be related to the theory of W-algebras.

Orbifold Hurwitz numbers and Eynard-Orantin invariants

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I will describe a generalisation of simple Hurwitz numbers due to Johnson, Pandharipande and Tseng and prove that they satisfy the topological recursion of Eynard and Orantin. This generalises the Bouchard-Marino conjecture and places Hurwitz-Hodge integrals, which arise in the Gromov-Witten theory of target curves with orbifold structure, in the context of the Eynard-Orantin topological recursion.

Translated points and contact rigidity

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I will discuss the role played by translated points of contactomorphisms in contact rigidity phenomena such as non-squeezing, orderability and the existence of bi-invariant metrics on the contactomorphism group. I will then either concentrate on presenting the construction of the discriminant metric on the contactomorphism group (which is joint work with Vincent Colin) or discuss an analogue for translated points of the Arnold conjecture on fixed points of Hamiltonian symplectomorphisms, and a joint work in progress with Yasha Savelyev and Egor Shelukhin to prove this conjecture by constructing a Floer homology theory for translated points.

On a certain generalization of Virasoro constraints for Frobenius manifolds

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We show that the Virasoro operators associated to an arbitray Frobenius manifold admit certain deformations which give additional constraints for the genus zero free energy of the Frobenius manifold. We discuss applications of such additional constraints and their analogues for higher genus free energies.

Gopakumar-Vafa invariants of local Calabi-Yau 3-Folds

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We will present a formula for Gopakumar-Vafa BPS invariants of local Calabi-Yau geometries given by the canonical line bundles of toric surfaces under some technical conditions. This verifies and extends a conjecture made by Katz-Klemm-Vafa based on M-theory.

Special Session 23
Triangulated Categories in Representation Theory of Algebras

Derived simple algebras

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An algebra is said to be derived simple if its derived category cannot be deconstructed into 'smaller' derived categories, more precisely, it is not the middle term of a nontrivial recollement where the two outer terms are again derived categories of algebras.

We will see that being derived simple strongly depends on the choice of derived categories: whether at bounded or unbounded level, whether considering finitely generated or arbitrary modules. We will clarify the connection between the different choices by discussing when recollements can be lifted or restricted between different levels of derived categories. We will then characterize derived simpleness on each level in terms of the height of ladders, that is, the number of adjacent recollements at unbounded level. This is joint work with Steffen Koenig, Qunhua Liu, Dong Yang.

The decorated mapping class group of a marked surface

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The main character of this talk is the decorated mapping class group $MCG_p(S, M)$ of a marked surface (S, M). We show that (in most cases) it is isomorphic to a group formed by automorphisms of the cluster algebra associated to (S, M), which can also be interpreted as a group of auto-equivalences of the corresponding cluster category $C(S, M)$. Moreover we describe the suspension functor of $C(S, M)$ geometrically, as an element in the decorated mapping class group of (S, M).

Autoequivalences under derived equivalences

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There are many examples where derived categories of coherent sheaves on some smooth projective variety are equivalent to the derived category of finite length modules over an artinian algebra, or to the singularity category of graded modules over a graded Gorenstein algebra, or both.

In these case, often one of the partners in the derived equivalences carries obvious autoequivalences, such as twists by line bundles on the geometric side or degree shifts in the graded case, that are quite mysterious on the equivalent incarnations.

We will review this situation and explain some classical examples where the "obvious" autoequivalences on one side can now be understood on the other side. Part of this is joint work in progress with Lutz Hille.

Singular equivalences with examples

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Two finite dimensional algebras are said to be singularly equivalent if there is a triangle equivalence between their singularity categories in the sense of Buchweitz and Orlov; this triangle equivalence is called a singular equivalence. We will report recent progress on singular equivalences with examples.

The representation type of non-degenerate QPs

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Let Q be a 2-acyclic quiver, and W a non-degenerate potential for Q. We show, that up to a few exceptions the Jacaobian algebra $\mathcal{P}(Q, W)$ is tame if and only if the quiver is mutation finite.

The exceptions are the following: The mutation finite quivers X_6, X_7 (found by Derksen and Owen) and the m-Kronecker quiver for $m \geq 3$ yield wild Jacobian algebras. The mutation finite quivers T_1 and T_2 corresponding to triangulations of a torus with one puncture resp. with one marked point admit non-degenerate potentials which can be either tame or wild.

The tame cases include virtually all known "derived-tame phenomena": (extended) Dynkin, tubular, skewed-clannish and deformations. Thus we obtain many examples of "tame" triangulalated 2-CY categories.

If time permits we discuss the uniqueness of non-degenerate potentials for most mutation finite quivers.

Geigle-Lenzing spaces and canonical algebras of dimension d (I)

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This is the first half of a report on ongoing joint work with Osamu Iyama, Hiroyuki Minamoto, and Steffen Oppermann. The second half will be given by Osamu Iyama.

Weighted projective lines were introduced by Geigle and Lenzing. One key property of these is that they give rise to hereditary categories with tilting objects, whose endomorphism rings are canonical algebras. Both weighted projective lines and canonical algebras have proven to be interesting objects in representation theory, and been studied intensively. In our talks we will introduce the notion of d-dimensional Geigle-Lenzing spaces, generalizing the concept of weighted projective lines. Also in this case we obtain a nice tilting bundle, whose endomorphism ring we call a d-canonical algebra. We will then focus on some properties of weighted projective lines which generalize nicely to the d-dimensional setup.

Geigle-Lenzing spaces and canonical algebras in dimension d (II)

Osamu Iyama
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This is the second half of a report on ongoing joint work with Martin Herschend, Hiroyuki Minamoto and Steffen

Oppermann. The first half will be given by Steffen Oppermann.
Weighted projective lines were introduced by Geigle and Lenzing. One key property of these is that they give rise to hereditary categories with tilting objects, whose endomorphism rings are canonical algebras. Both weighted projective lines and canonical algebras have proven to be interesting objects in representation theory, and been studied intensively. In our talks we will introduce the notion of d-dimensional Geigle-Lenzing spaces, generalizing the concept of weighted projective lines. Also in this case we obtain a nice tilting bundle, whose endomorphism ring we call a d-canonical algebra. We will then focus on some properties of weighted projective lines which generalize nicely to the d-dimensional setup.

Cohomological length functions

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A cohomological functor from a triangulated category into the category of finite length modules over some ring gives rise to an integer valued function on the set of all objects. One might ask: What are the characteristic properties of such a function, and can one recover the functor from the corresponding function? Somewhat surprisingly, we can offer fairly complete answers to both questions. Examples from representation theory will illustrate these answers, and we discuss some cases when all cohomological length functions can be classified.

Invariant flags for nilpotent operators, and weighted projective lines

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This is joint work with Dirk Kussin and Hagen Meltzer extending a previous analysis of the invariant subspace problem for nilpotent operators (of finite dimensional vector spaces over an algebraically closed field k). The problem itself goes back to G. Birkhoff (1934) and was treated in detail by C.M. Ringel and M. Schmidmeier (2006-2008); it is further related to research by D. Simson (2007) and Pu Zhang (2011). In previous work with Kussin and Meltzer we did establish a relationship of the invariant subspace problem to singularity theory, more specifically we showed a link to the theory of weighted projective lines $\mathbf{X}$ of special weight type $(2, 3, c)$. In this talk, we show that for arbitrary triple weight type (a, b, c), a suitable factor category $\mathcal{S}$ of the category of vector bundles on $\mathbf{X}$, is equivalent to the category of graded representations of nilpotency degree bounded by c, equipped with two invariant flags of graded sub-representations , where the flag lengths are determined by the integers a and b. The category $\mathcal{S}$ carries a natural exact structure which is almost-Frobenius, but in general not Frobenius. It's associated stable category $\underline{\mathcal{S}}$ is triangulated and shown to be equivalent to the singularity category of the (suitably graded) triangle singularity $x^a + y^b + z^c$.

Cluster categories and independence results for exchange graphs

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Cluster categories are triangulated categories that have been used to study S.Fomin and A.Zelevinsky's cluster algebras. They come equipped with special objects, called cluster-tilting objects, that are obtained from one another by a process called mutation; this gives rise to an exchange graph. In this talk, we will study properties of this exchange graph, and see how it is related to the exchange graph of a cluster algebra. We will then apply these results to a conjecture of Fomin-Zelevinsky stating that the exchange graph of a cluster algebra does not depend on the choice of the ring of coefficients over which the algebra is defined. (This is joint work with G.Cerulli Irelli, B.Keller and D.Labardini-Fragoso.)

Triangulated categories and tau-tilting theory

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This talk is based upon work with Adachi and Iyama. We explain how work on triangulated categories (cluster categories and more generally, 2-Calabi-Yau categories) inspired an extension of some aspects of classical tilting theory, which we have called tau-tilting theory.

From submodule categories to preprojectivealgebras

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Let $S(n)$ be the category of invariant subspaces of nilpotent operators with nilpotency index at most n. Such submodule categories have been studied already in 1936 by Birkhoff, they have attracted a lot of attention in recent years, for example in connection with some weighted projective lines (Kussin, Lenzing, Meltzer). On the other hand, we consider the preprojective algebra of type A_n; the preprojective algebras were introduced by Gelfand and Ponomarev, they are now of great interest, for example they form an important tool to study quantum groups (Lusztig) or cluster algebras (Geiss, Leclerc, Schroeer). Direct connections between the submodule category S(n) and the module category of the preprojective algebra of type A_{n-1} have been established quite a long time ago by Auslander and Reiten, and recently also by Li and Zhang, but apparently this remained unnoticed. The lecture is based on joint investigations with Zhang Pu and will provide details on this relationship. As a byproduct we see that here we deal with ideals I in triangulated categories T such that I is generated by an idempotent and T/I is abelian.

Exact categories over Cohen–Macaulay rings

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It is known that the following full subcategories of finitely generated modules are Frobenius categories:

- the category of maximal Cohen–Macaulay modules over a Gorenstein ring,
- the category of totally reflexive (= finitely generated Gorenstein projective) modules over a noetherian ring,
- the category of special Cohen–Macaulay modules over a rational surface singularity.

In this talk, we give a systematic generalization of this fact over a Cohen–Macaulay ring. More precisely, we study certain full subcategories of finitely generated modules, and investigate when they are exact categories with enough projectives and enough injectives. This talk is based on joint work with Osamu Iyama.

Toward repetitive equivalences

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We say two artin algebras R and S are repetitive equivalent provided that their repetitive algebras are stably equivalent. By Happel's result, repetitive equivalences between artin algebras of finite globe dimension imply derived equivalences. On the other hand, by results of Rickard, Chen etc., if two artin algebras are derived equivalent, then their repeptitive algebras are derived equivalent, and hence stably equivalent. Thus, repetitive equivalences are more general than derived equivalences. The paper will suggest a way teward the Morita theory of repetitive equivalences.

Some results related to Poisson (co)homology

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Poisson (co)homologies of some Poisson polynomial algebras are used to calculate the Hochschild (co)homologies of some Artin-Schelter regular algebras recently. In this talk, I will concentrate on some recent work on Poisson (co)homologies.

Rigid morphisms, exact pairs and applications

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In this talk, we shall introduce relatively exact pairs of ring homomorphisms, define non-commutative tensor products over such pairs, which generalize the usual notion of tensor products over commutative rings, and construct recollements of derived module categories of rings involving those non-commutative tensor products. This consideration is then used to understand the relationship of finitistic dimensions and algebraic K-theory of rings in a recollement.
The content of this talk is taken from a joint work with Hongxing Chen at CNU.

T-structures and torsion pairs in a $2-$Calabi-Yau triangulated category

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For an indecomposable $2-$Calabi-Yau triangulated category $\mathcal{C}$ with a cluster tilting object, we prove that there are no non-trivial t-structures or non-trivial co-t-structures in $\mathcal{C}$. This allows us to give a classification of torsion pairs in this triangulated category $\mathcal{C}$. Furthermore we determine the hearts of torsion pairs in the sense of Nakaoka: They are equivalent to the module categories over the endomorphism algebras of the cores of the torsion pairs.
This is a joint work with Yu Zhou.

4 Contributed Talks

Contributed Talks Group 1
Geometry and Analysis

Bounded operators on Hilbert C^*-modules

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We study the problem of amenability for the C^*-algebra $\mathcal{B}(\mathcal{E})$ of bounded operators in a Hilbert C^*-module $\mathcal{E}$ on a C^*-algebra $\mathcal{A}$. When $\mathcal{A}$ is a von Neumann algebra and $\mathcal{E}$ is full and self dual, we show that $\mathcal{B}(\mathcal{E})$ is amenable (nuclear) if and only if $\mathcal{A}$ is injective and $\mathcal{E}$ is finitely generated. We find similar results for the case where $\mathcal{A}$ is a C^*-algebra and $\mathcal{E}$ is weakly self dual. We briefly study the predual and type theory of $\mathcal{B}(\mathcal{E})$ when it is a von Neumann algebra. This is a joint work with M. Bagher Asadi.

Gromov-Hausdorff hyperspaces of $\mathbf{R^n}$

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The Gromov-Hausdorff distance d_{GH} was introduced in 1981 by M. Gromov. It turns the set GH of all isometry classes of compact metric spaces into a metric space. For two compact metric spaces X and Y the number $d_{GH}(X,Y)$ is defined to be the infimum of all Hausdorff distances $d_H(i(X), j(Y))$ for all metric spaces M and all isometric embeddings $i : X \to M$ and $j : Y \to M$. Clearly, the Gromov-Hausdorff distance between isometric spaces is zero; it is a metric on the set GH of isometry classes of compact metric spaces. The metric space $(\mathrm{GH}, \mathrm{d_{GH}})$ is called the Gromov-Hausdorff hyperspace. It is a challenging open problem to understand the topological structure of this metric space. The talk contributes towards this problem. We denote by $\mathrm{GH}(\mathbf{R^n})$ the subspace of GH consisting of the classes $[E]$ whose representative E is a metric subspace of $\mathbf{R^n}$. We are interested in the Gromov-Hausdorff hyperspaces $\mathrm{GH}(\mathbf{R^n})$ and $\mathrm{GH}(\mathbf{R^n}, \mathrm{d}) = \{\mathrm{X} \in \mathrm{GH}(\mathbf{R^n}) \mid \mathrm{diam\,X} \le \mathrm{d}\}, \quad \mathrm{d} > 0$. In particular, we will prove that $\mathrm{GH}(\mathbf{R^n})$ is homeomorphic to the Hilbert cube with a removed point.

Developments of harmonic maps into biharmonic maps

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Harmonic maps between Riemannian manifolds was first established by Eells and Sampson [11] (Chiang's PhD advisor) in 1964. Biharmonic maps (generalizing harmonic maps) were first studied by Jiang [12]–[14] in 1986. We present an overview of the developments of harmonic maps into biharmonic maps based on [1]–[10]. We first discuss the developments of harmonic maps on crucial topics including regularity, maps of surfaces, maps into Kähler manifolds, maps into groups and Grassmannians, loop groups and integrable systems, harmonic morphisms, maps of singular spaces, and transversally harmonic maps. We then present the developments of biharmonic maps on topics including Riemannian immersions and submersions, conformally biharmonic maps, biharmonic morphisms, biharmonic homogeneous real hypersurfaces, regularity, transversally biharmonic maps, conservation law, and biharmonic maps into Lie groups and integrable systems.

[1] Y.-J. Chiang, *Developments of harmonic maps, wave maps and Yang-Mills fields into biharmonic maps, biwave maps and bi-Yang-Mills fields*, Birkhäuser, Springer, Basel, in the series of "Frontiers in Mathematics," XXII+399, 2013, in press.
[2] Y. J. Chiang, *Harmonic maps of V-manifolds*, Ann. Global Anal. and Geom., Vol. 8 (1990), no. 3, 315–344.
[3] Y.-J. Chiang, *Spectral geometry of V-manifolds and its applications to harmonic maps*, Proc. Symp. Pure Math., Amer. Math. Soc., Vol. 54 (1993), Part 1, 93-99.
[4] Y.-J. Chiang, *f-biharmonic maps between Riemannian manifolds*, J. of Geom. and Symmetry in Physics, Vol. 27 (2012), 45–58.
[5] Y. J. Chiang, *Harmonic and biharmonic maps of Riemann surfaces*, Global J. of Pure and Applied Math., Vol. 9 (2013), no. 2, 109-124.
[6] Y.-J. Chiang and A. Ratto, *Harmonic maps on spaces with conical singularities*, Bull. Soc. Math. France, Vol. 120 (1992), no. 3, 251–262.
[7] Y.-J. Chiang and H. Sun, *2-harmonic totally real submanifolds in a complex projective space*, Bull. Inst. Math. Acad. Sinica, Vol. 27 (1999), no. 2, 99–107.
[8] Y.-J. Chiang and H. Sun, *Biharmonic maps on V-manifolds*, Inter. J. Math. Math. Sci., Vol. 27 (2001), no. 8, 477–484.
[9] Y.-J. Chiang and R. Wolak, *Transversally biharmonic maps between foliated Riemannian manifolds*, Internat. J. of Math., Vol. 19 (2008), no. 8, 981–996.
[10] Y.-J. Chiang and R. Wolak, *Transversally f-harmonic and transversally f-biharmonic maps between foliated Riemannian manifolds*, JP J. of Geom. and Top., Vol. 13 (2013), no. 1, 93–117.
[11] J. Eells and J. H. Sampson, *Harmonic mappings of Riemannian manifolds*, Amer. J. of Math., Vol. 86 (1964), 109–160.
[12] G. Y. Jiang, *2-harmonic maps and their first and second variational formulas* Annals of Math., China, Ser. A7 (1986), no. 4, 389-402.
[13] G. Y. Jiang, *2-harmonic isometric immersions between Riemannian manifolds*, Annals of Math., China, Ser. A7 (1986), no. 2, 130-144.
[14] G. Y. Jiang, *The conservation law of biharmonic maps between Riemannian manifolds*, Acta Math. Sinica, Vol. 30 (1987), no. 2, 220–225.

Hamiltonian group of self product

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Let (X, ω) be a symplectic manifold and consider the self product $(M, \Omega) = (X \times X, \omega \oplus -\omega)$. We consider the Hamiltonian groups $\mathrm{Ham}(X, \omega) \times \mathrm{Ham}(X, -\omega)$ and $\mathrm{Ham}(M, \Omega)$. There is a natural inclusion from the first group into the second. We give an example where the inclusion map induces a proper inclusion of the fundamental groups. This is joint work with F. Lalonde.

A McShane-type identity for closed surfaces

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We prove a McShane-type identity— a series, expressed in terms of geodesic lengths, that sums to 2π for any closed hyperbolic surface with one distinguished point. To do so, we prove a generalized Birman-Series theorem showing that the set of complete geodesics on a hyperbolic surface with large cone-angles is sparse.

A new gluing recursive relation for Linear Sigma Model of P^1-orbifold

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The study of the moduli space plays an important role in enumerative geometry, symplectic geometry and mathematical physics. Given $X = [P^1/Z_r]$ and let $x' = ([0]_a, [\infty]_b)$ be the 2-tuple of twisted sectors on X. In this talk, we construct two different compactifications of the moduli space $M_{0,2}(X, d[P^1/Z_r], x')$: Nonlinear Sigma Model $M_d^{x'}$ and Linear Sigma Model $N_d^{x'}$. Relations between $M_d^{x'}$ and $N_d^{x'}$ are studied and a new gluing recursive relation on $N_d^{x'}$ is discussed.

Cb-frames and the completely bounded approximation property for operator spaces

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We introduce the concept of cb-frames for operator spaces, and give characterizations of completely complemented subspaces of operator spaces with cb-bases. We apply the results to discrete group C^*-algebras. In particular, we show that there is a natural cb-frame for the reduced free group C^*-algebra $C_r^*(\mathrm{F}_n)$ of n-generators which is derived from the infinite convex decomposition of the biorthogonal system $(\lambda_s, \delta_s)_{s\in \mathrm{F}_n}$. We show that there is a separable Hilbert operator space which can not be a subspace of an operator space with a cb-basis, then we introduce a natural question to ask for an essential characterization of subspaces of operator spaces with cb-bases.
This is joint work with Zhong-Jin Ruan.

Some inequalities for unitarily invariant norms

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We shall prove the inequalities

$$\begin{aligned}|||(A+B)(A+B)^*||| &\le |||AA^*+BB^*+2AB^*||| \\ &\le |||(A-B)(A-B)^*+4AB^*|||\end{aligned}$$

for all $n \times n$ complex matrices A, B and all unitarily invariant norms $|||\cdot|||$. If furhter A, B are Hermitian positive definite it is proved that

$$\prod_{j=1}^{k} \lambda_j(A \sharp_\alpha B) \le \prod_{j=1}^{k} \lambda_j(A^{1-\alpha}B^\alpha), \quad \begin{array}{l}1 \le k \le n, \\ 0 \le \alpha \le 1,\end{array}$$

where $\sharp_\alpha$ denotes the operator means considered by Kubo and Ando and $\lambda_j(X)$, $1 \le j \le n$, denote the eigenvalues of X arranged in the decreasing order whenever these all are real. A number of inequalities are obtained as applications.

On automorphism groups of Hua domains

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Hua domains are the generalization of Cartan-Hartogs domains, which were introduced by Weiping Yin around the end of 20th century (named after Chinese mathematician Luogeng Hua). We will first give a brief introduction to Hua domains, and then give a complete description of their automorphism groups.

Weighted harmonic spaces

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In 1994, R. Aulaskari and Peter Lappan introduced the $\mathcal{Q}_p$ spaces $p > 0$, of analytic functions defined in the unit disk of the complex plane. Considering that analytic functions $f(z) = u(x, y) + iv(x, y)$ consist of a pair of harmonic conjugate functions, in this paper we consider weighted harmonic spaces, consisting of real harmonic functions defined in the unit disk of the plane. We study their basic properties and relationships with some other weighted function spaces.

Variable equation of state for a dark energy model with linearly varying deceleration parameter

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We present a dark energy model in an inhomogeneous plane symmetric space-time by considering a linearly varying deceleration parameter. In the model, the equation of state (EoS) parameter ω is found to be time dependent. For different cosmic times, we obtain quintessence, vacuum energy and phantom fluid dominated universe. The universe we described has finite lifetime and ends with a big-rip which is a result consistent with recent cosmological observations.

Diversities and the geometry of hypergraphs

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There are well-known connections between certain combinatorial optimization problems and the geometry of metric embeddings of graphs. Instead of metrics, we consider diversities, which are a generalization of the concept of metrics to functions of finite sets of points, rather than just pairs of points. We show that analogous to the relation between flow problems and combinatorial optimization in graphs, there are intimate relations between diversities and a different set of flow problems, including fractional Steiner tree packing and optimal flows in hypergraphs. We discuss polynomial approximation algorithms that would result from a effective theory of embedding diversities into ℓ_1.

On the potential function of gradient steady Ricci solitons

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We prove that the infimum of the potential function of a gradient steady Ricci soliton decays linearly. As consequences, a gradient steady Ricci soliton with bounded potential function must be Ricci-flat, and no gradient steady Ricci soliton admits uniformly positive scalar curvature.

New heat kernel estimates on manifolds with negative Ricci curvature lower bound

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Apply the new Li-Yau type Harnack estimates for the heat equations on manifolds with $Ric(M) \geq -K$, $K \geq 0$, which established by Junfang Li and the author [Advance in Mathematics 226(5) (2011), 4456-4491], I prove a new upper bound estimate for the heat kernel $H(x, y, t)$ of manifolds with $Ric(M) \geq -K$,

$$H(x,y,t) \leq A_K(t) V_x^{-1/2}(\delta(t)) V_y^{-1/2}(\delta(t)) \cdot \exp\left[-\frac{d^2(x,y)}{4t} + [1 + d^2(x,y)] B_K(t) \right],$$

where $A_K(t), B_K(t) : [0, \infty) \to [0, \infty)$ are bounded functions, and $\delta(t) \sim t$ as $t \to 0$ and $\delta(t) \sim 1$ as $t \to \infty$. While in the seminal work of Li-Yau [Acta Math. 156 (1986) 153-201.], the heat kernel upper bound estimates had δ-loss:

$$H(x,y,t) \leq C(\delta,n) V_x^{-1/2}(\sqrt{t}) V_y^{-1/2}(\sqrt{t}) \cdot \exp\left[-\frac{d^2(x,y)}{(4+\delta)t} + C_1 \delta K t \right],$$

where constant $C(\delta, n) \sim \exp\left[\frac{c_1}{\delta}\right]$ as $\delta \to 0$, due that there was non-sharp Harnack estimates on manifolds with $Ric(M) \geq -K$.

Contributed Talks Group 2
Algebra and Number Theory

Universal objects for free G-spaces

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Throughout G is assumed to be a compact Lie group. A G-space U is called universal for a given class of G-spaces G-$\mathcal{P}$, if $U \in G$-$\mathcal{P}$ and U contains as a G-subspace a G-homeomorphic copy of any G-space X from the class G-$\mathcal{P}$.
In this talk we shall present universal G-spaces in the class of all paracompact (respectively, metrizable, and separable metrizable) free G-spaces. Recall that for a G-space X and a point $x \in X$ the stabilizer (or stationary subgroup) of x is defined by $G_x = \{g \in G \mid gx = x\}$. If $G_x = \{e\}$ for all $x \in X$ then we say that the action of G is *free* and X is a *free G-space*. Denote by $Cone\, G$ the cone over G endowed with the natural action of G induced by left translations. Let $J_\infty(G)$ be the infinite join $G * G * \ldots$; it is just the subset of the countable product $(Cone\, G)^\infty$ consisting of all those points $(t_1g_1, t_2g_2, \ldots)$ for which only a finite number of $t_i \neq 0$ and $\sum_{i=1}^{\infty} t_i = 1$. We let G act coordinate-wise on $J_\infty(G)$. Denote by I the unit interval $[0, 1]$ and by I^τ the Tychonoff cube of a given infinite weight τ endowed with the trivial action of G.
We prove that for every infinite cardinal number τ, the product $J_\infty(G) \times I^\tau$ is universal in the class of all paracompact free G-spaces of weight $\leq \tau$. A similar result for metrizable free G-spaces of weight $\leq \tau$ is also obtained.

Categorification in topology, geometry and combinatorics

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Categorification become an essential tool in many areas of modern mathematics. By generalizing algebraic concepts from the classical set theory to the context of higher category theory, a program of higher dimensional algebra is initiated as an attempt to unify quantum field theory with traditional algebraic topology. The purpose of the talk is to reflect on one of the central themes of Grothendieck's work about the deep relation between topos theory and homotopy theory, where he emphasized the importance of the sheaf theoretical objects corresponding to higher categorical structures. Such sheaf-theoretical and cohomological structures associated to higher categories are ubiquitous in many areas of mathematics like (algebraic) topology, geometry and combinatorics. We will shed more light on author's work on fibrations of bicategories, stemming from mostly unpublished work by Bénabou, in his investigations of logical aspects of fibred categories, and his attempt to give foundations of naive category theory by using fibred categories. We will briefly describe theory of 2-fibrations, Grothendieck construction for bicategories, fibered bicategorical Yoneda lemma and homotopy theoretic view of 2-fibrations, connecting the whole theory to Lurie's cartesian fibrations. Finally, we relate the 2-dimensional fibrations with Joyal theory of species of structures in combinatorics. The basis for this connection is Zawadowski's interpretation of amalgamated signatures by means of lax monidal fibrations of categories. By categorifying the latter notion, we describe lax monoidal fibrations of bicategories as a natural organizational tool for categorified signatures which appear in a work of Cheng and Hermida, Makkai and Power, and which consequently give a basis for generalized species of structures.

Realising Galois groups via Galois representations

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Gabor Wiese first realised families of finite simple groups as Galois groups over the field of rational numbers, $\mathbb{Q}$, by controlling the images of certain Galois representations. Since then, Galois representations have been used to realise various other families of finite simple groups as Galois groups over $\mathbb{Q}$. We will discuss results which enable us to realise some new families of finite simple groups and new techniques which enable us to realise non-simple finite groups as Galois groups over $\mathbb{Q}$. Some of this work is joint work and still in progress.

L-functions from Langlands-Shahidi method for $GSpin$ groups and the generic Arthur L-packet conjecture

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L-functions are very interesting tools that number theorists have been using since 18th century. Those also appear in the local Langlands conjecture. Briefly, the local Langlands conjecture asserts that there exists a 'natural' bijection between two different sets of objects: Arithmetic (Galois or Weil-Deligne) side and analytic (representation theoretic) side. In each side, we can define the L-functions of those objects. The L-functions from analytic side are defined by Shahidi (Langlands-Shahidi method) and the L-functions from arithmetic side are Artin L-functions. The natural question is whether two L-functions are equal through the local Langlands correspondence. If it is, we can use the properties of local L-functions from arithmetic side to study local L-packet, the object in the analytic side, which is the set of irreducible admissible representations of quasi split group G over p-adic field. The equality of local L-functions has an interesting application in proving the generic Arthur L-packet conjecture. The generic Arthur L-packet conjecture states that if the L-packet attached to Arthur parameter has a generic member, then it is tempered. This conjecture can be considered as local version of generalized Ramanujan conjecture. In this talk, I will explain those in the case of split $GSpin$ groups. Furthermore, I will explain the classification of strongly positive discrete series representations of $GSpin$ groups over p-adic field which is one of the main tools in the proof of the equality of L-functions. If time permits, I will explain the generalized Ramanujan conjecture for $GSpin$ groups.

Derived equivalences and Gorenstein dimension

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A ring A is said to be left (resp., right) coherent if every finitely generated left (resp., right) ideal of it is finitely presented (see [3]). Let A, B be derived equivalent left and right coherent rings (see [5]). In [4] Kato showed that a standard derived equivalence induces an equivalence between the triangulated categories consisting of complexes of finite Gorenstein dimension and that a derived equivalence induces an equivalence between the projectively stable categories of modules of Gorenstein dimension zero (see [1] and [2]) if either inj dim $A < \infty$ or inj dim $A^{\text{op}} < \infty$. In this talk, we provide alternative proofs of these results from another point of view. Also, we do not assume the existence of standard derived equivalence or finiteness of selfinjective dimension.

[1] M. Auslander and M. Bridger, *Stable module theory*, Mem. Amer. Math. Soc., **94**, Amer. Math. Soc., Providence, R.I., 1969.
[2] R.-O. Buchweitz, *Maximal Cohen-Macaulay modules and Tate-cohomology over Gorenstein rings* (1987), 155, unpublished manuscript, available at https://tspace.library.utoronto.ca/handle/1807/16682.
[3] S. U. Chase, *Direct products of modules*, Trans. Amer. Math. Soc. **97** (1960), 457–473.
[4] Y. Kato, *On derived equivalent coherent rings*, Comm. Algebra **30** (2002), no. 9, 4437–4454.
[5] J. Rickard, *Morita theory for derived categories*, J. London Math. Soc. (2) **39** (1989), no. 3, 436–456.

A generalized Koszul theory

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Let A be a positively graded, locally finite k-algebra where A_0 is a finite-dimensional algebra whose finitistic dimension is 0. In this talk we introduce a generalized Koszul theory preserving many classical results, and describe an explicit correspondence between this generalized theory and the classical theory. Applications in representations of certain categories and extension algebras of standard modules of standardly stratified algebras will be described if time allows.

On symmetric association schemes with $k_1 = 3$ and $m_i = 3$

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In 2006, Bannai and Bannai classified primitive symmetric association schemes with $m_1 = 3$. In their paper, the hardest case was $k_1 = 3$. Even though, (primitive) symmetric association schemes with $k_1 = 3$ were classified by Yamazaki in 1998, they avoided the use of the difficult and deep result of Yamazaki. In this talk, we generalize the result of Bannai and Bannai.

Triangulated categories from categories of specail exact squences

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Let A be an artinian algebra over an algebraically closed field k. Let $\mathcal{F}$ be the category consisting of all four-term exact sequences in $modA$. Let $\mathcal{C}$ be the full subcategory of $\mathcal{F}$ consisting of all exact sequences with two middle terms projective modules in $modA$. It is proved that $\mathcal{C}$ is contravariantly finite. As applications, it is proved that $\mathcal{C}$ is a Frobenius category and has Auslander-Reiten sequences provided A is an selfinjective algebra. Furthermore, it is proved that the stable category $\underline{\mathcal{C}}$ equals to $\mathcal{C}/\mathcal{H}$ as factor categories, where $\mathcal{H}$ is the set of all homotopic relations, and they are both equivalent to the stable category $\underline{modA}$. An interesting result is that these three categories $\underline{\mathcal{C}}$, $\mathcal{C}/\mathcal{H}$ and $\underline{modA}$ are equivalent as triangulated categories.

Contributed Talks Group 3
Discrete Mathematics

Numerical verification method for well conditioned spherical t-designs

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A set $\mathcal{X}_N$ of N points on the unit sphere is a spherical t-design if the average value of any polynomial of degree at most t over $\mathcal{X}_N$ is equal to the average value of the polynomial over the sphere. In this talk, we focus on the computational construction of spherical t-designs on the unit sphere $\mathbb{S}^2 \subset \mathbb{R}^3$ when $N \geq (t+1)^2$, the dimension of the space $\mathbb{P}_t$ of spherical polynomials of degree at most t. We show how to construct well conditioned spherical designs with $N \geq (t+1)^2$ points by maximizing the determinant of a matrix while satisfying a system of nonlinear constraints for $1 \leq t \leq 100$. Interval methods are then used to prove the existence of a true spherical t-design very close to the calculated points and to provide a guaranteed interval containing the determinant. The resulting spherical designs have good geometrical properties (separation and mesh norm). We discuss some open problems on the distribution of point set over the sphere.

This is a joint work with X.Chen, I. H. Sloan and R. S. Womersley.

Edge colouring graphs with bounded colour classes

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An *edge colouring* of a graph G is a function which assigns a colour to each edge of G in such a way that adjacent edges receive distinct colours. The minimum number of colours used by an edge colouring of G is a well known and studied graph parameter called *chromatic index* and denoted by $\chi'(G)$. It was proved by Holyer in 1981 that computing $\chi'(G)$ is in general NP-hard. We consider a variation of the edge colouring problem, which may be of interest for applications. Specifically, we consider edge colourings of G such that no colour is assigned to more than B edges, where B is a positive integer fixed in advance (clearly such edge colourings always exist). We call any such colouring a *B-bounded edge colouring of G*. The minimum number of colours in a B-bounded edge colouring of G is a graph parameter which we denote by $\chi'_B(G)$ and call *B-bounded chromatic index*. A B-bounded edge colouring which uses exactly $\chi'_B(G)$ colours is called an *optimal B-bounded edge colouring of G*.

It is not difficult to see that, for every graph G,

$$\chi'_B(G) = \max\{\chi'(G), \lceil \frac{|E(G)|}{B} \rceil.$$

This prompts the question of whether the parameter χ'_B and an optimal B-bounded edge colouring can be computed in polynomial time for a fixed value of B. Our goal in this talk will be to answer this question in the affirmative. This is joint work with Romeo Rizzi [1].

[1] R. Rizzi and D. Cariolaro, *Polynomial time complexity of Edge Colouring Graphs with Bounded Colour Classes,* Algorithmica (2013), in press, doi: 10.1007/s00453-013-9746-7.

Realizing joint degree matrices

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The Joint Degree Matrix of a graph is a matrix whose (i, j) entry is the number of edges connecting vertices of degree i to vertices of degree j. A given matrix is called realizable if it is the joint degree matrix of a simple graph. As in the case of degree sequences, there is a simple set of conditions for when a matrix is realizable, as well as an operation that can be used to transform any realization into any other realization. We discuss these problems, as well as the extremal question of when a joint degree matrix is uniquely realizable.

Generalization of Legendre polynomials theory

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In all of n-order polynomials that highest coefficient is 1čňLegendre polynomials are in the interval $[-1, 1]$ with the least square error of zero polynomials, that for $Pn(x) = x^n + a(n-1)x^{n-1} + ... + a1x + a0$, making $\int[Pn(x)]^2dx = min$. Promotes the Legendre multinomialbasic principle: In all of n-order polynomials that highest coefficient is not 1, namely $an \neq 1$,there must be a new polynomials $Gn(x) = x^n + a(n-1)x^{n-1} + ... + a1x + a0$, making $\int[Gn(x)]^2dx = min$. Through discussion of the square error minimization, leads to the new polynomials establishment necessity. For convenient on elaboration in this abstract,called it "Gn(x) polynomial" (Generalization of Legendre polynomial). First the existence of Gn(x) polynomials issues are studied: By establishing Gn(x) equation the ordinary solution expressions in the interval $|x| < 1$ are given, have proven that when n is positive integer and the interval is in $|x| \leq 1$, two linear independence special solutions of them are Gn(x) polynomials, and provide the general term expression; Second, the geometric meaning of Gn(x) polynomials are discussed, have proven that Gn(x)polynomials are the polynomials that in $[-1, 1]$ with the error squares value are the least; Third, the main properties of Gn(x) polynomials are introducedčňwhich including Gn(x)polynomials recurrence formula, the orthogonality, the odevity, the squares value area, the former n=9 polynomials, the corresponding geometry, and so on. Last, some special applications of Gn(x) polynomials under different boundary conditions are given: Combined with the best Chebyshev approximation theory they can constitute maximum error minimizing least square approximation; Combined with the Least Absolute Deviation approximation theory can constitute zero error type least square approximation; Under the conditions of an=1 form the Legendre polynomial,and so on.

The subsets counting problems and their applications

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Let G be an abelian group and D be a finite subset of G. Denote $N(b)$ to be the number of subsets S in D such that $\sum_{x\in S} x = b$ and $N_k(b)$ to be the number of k-subsets S in D such that $\sum_{x\in S} x = b$. When G is the set of integers, the decision version of the subset sum problem, i.e., determining if $N(b) > 0$, is a well-known **NP**-complete problem. And its counting version, the explicit enumeration of $N(b)$ or $N_k(b)$, is a #**P**-complete problem. In this talk, we will investigate these problems from a mathematical point of view, and introduce their relations to additive combinatorics, coding theory and computer sciences.

Paths and cycles of interval graphs

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We recently find a linear time algorithm for solving the 1-Fixed-Endpoint Path Cover Problem on interval graphs. The design and the analysis of this algorithm motivate us to develop many properties on the paths and cycles of interval graphs and graphs. In this short presentation, we report a series of equivalent characterizations of Hamiltonian connectedness and other path/cycle properties of interval graphs.

This is joint work with Yaokun Wu.

The spectrum of 3-way k-homogeneous Latin trades

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The theory of Latin trades has a deep and interesting structure, with connections to permutation groups, geometry and topology. The study of μ-way k-homogeneous Latin trades has received attention recently. The efforts of five publications completed the spectrum of the orders of 2-way k-homogeneous Latin trades. This was followed by a recent paper (Bagheri Gh., et al. 2012), which focused particularly on the 3-way k-homogeneous Latin trades with $k \leq 15$. In this talk, I will give a brief report on the existence of μ-way k-homogeneous Latin trades, including three new constructions that complete the 3-way k-homogeneous Latin trade spectrum for all but a handful of values. We will also provide the directions for further research motivated by this work.

On the fractional metric dimension of tree graphs

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Let G be a finite, simple, and connected graph. The *distance* between any two vertices $u, v \in V(G)$, denoted by $d_G(u, v)$, is the length of a shortest $(u - v)$ path in G. A vertex $x \in V(G)$ is called *resolve* a pair $\{u, v\}$ of vertices of G if $d_G(u, x) \neq d_G(v, x)$. For $u, v \in V(G)$, the set of all vertices which resolve the pair $\{u, v\}$ is denoted by $R_G\{u, v\}$. A real value function $g : V(G) \to [0, 1]$ is called a *resolving function* of G if $g(R_G\{u, v\}) \geq 1$ for any two distinct vertices $u, v \in V(G)$. The *fractional metric dimension*, denoted by $dim_f(G)$, is given by $dim_f(G) = \min\{|g| : g$ is a resolving function of $G\}$, where $|g| = g(V(G))$. In this paper, we determine the fractional metric dimension for tree graph T_n of order $n \geq 3$.

Unimodality of genus distribution of ladders

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Given a graph,its genus distribution is unimodal? As though many results about genus distribution of graphs have obtained, there are only several those about unimodality of genus distribution of graphs. In this talk, unimodality of genus distri- bution of some graphs are verified.

The lit-only σ-game

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Let G be a finite graph with vertex set V which may not necessarily be loopless. For each $v \in V$, let $\alpha_v \in \mathbf{F}_2^V$ be the map which takes value 1 on $w \in V$ if and only if there is an edge between v and w in G; let $\mathcal{T}_v$ be the linear map on $\mathbf{F}_2^V$ that sends $x \in \mathbf{F}_2^V$ to itself if $x(v) = 0$ and sends $x \in \mathbf{F}_2^V$ to $x + \alpha_v$ if $x(v) = 1$. Note that $\mathcal{T}_v$ is a transvection when v is not a loop in G while $\mathcal{T}_v$ is an idempotent when v is a loop in G. We consider the digraph Γ with vertex set $\mathbf{F}_2^V$ and arc set $\{(x, \mathcal{T}_v(x) : x \in \mathbf{F}_2^V, v \in V\}$, which is the phase space of the lit-only σ-game on G.

We determine the reachability relation for the digraph Γ. A surprising corollary of this work is that, for $\alpha, \beta \in \mathbf{F}_2^V$, basically, α can reach β in Γ if and only if $\alpha - \beta$ lies in the binary linear subspace spanned by $\{\alpha_v : v \in V\}$.

An important step of our work is to define the line graph of a multigraph and to provide a forbidden subgraph characterization. If the graph G is loopless, as an application of our knowledge of the corresponding digraph Γ, we are able to determine the multiplicative group generated by $\{\mathcal{T}_v : v \in V\}$. We also indicate possible approaches on extending the work here to the general case of G being a digraph.

This is joint work with Yaokun Wu.

Pancyclicity of 4-connected $\{K_{1,3}, Z_8\}$-free graphs

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A graph G is said to be pancyclic if G contains cycles of lengths from 3 to $|V(G)|$. In this paper, we show that every 4-connected claw-free Z_8-free graph is either pancyclic or is the line graph of the Petersen graph. This implies that every 4-connected claw-free Z_6-free graph is pancyclic, and every 5-connected claw-free Z_8-free graph is pancyclic.

The number of subtrees of a tree

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In this talk, we consider how to determine the maximum and minimum number of subtrees a tree with a given degree tree sequence. It is proven that the greedy tree among all trees with the same degree sequence has the maximum number subtrees, while it is tough to determine which tree has minimum number of subtrees. This work is joined with Daniel Gray, Hua Wang, and Xiu-Mei Zhang.

Contributed Talks Group 4
Computational Mathematics & Optimization

A semidefinite approximation for symmetric travelling salesman polytopes

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In this talk we will present a positive semidefinite approximation of compact convex sets introduced by A. Barvinok and E. Veomett [1]. In particular we will discuss the behaviour of this relaxation when the convex sets to be approximated are the Traveling Salesman Polytopes T_n and $T_{n,n}$ associated to the complete graphs K_n and $K_{n,n}$ respectively. E. Veomett has shown that the scaling of the $k-$th approximation by $n/k+O(1/n)$ contains the polytope T_n for $k \leq \lfloor n/2 \rceil$. Here, we will show that these metric bounds can be improved by a factor of $\frac{1}{3}\sqrt{\frac{k-1}{\frac{n}{2}-1}} + \frac{2}{3}$ for the case when n is even. Finally, we will show new metric bounds for the approximation of the polytope $T_{n,n}$.

This results are joint work with M. Velasco and are part of my master's dissertation at the University of los Andes.

[1] Veomett, Ellen. *A positive semidefinite approximation of the symmetric traveling salesman polytope.* Discrete Comput. Geom. 38 (2007), no. 1, 15-28.

An analysis of HDG methods for the Helmholtz equation

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In this talk we discuss the hybridizable discontinuous Galerkin (HDG) methods for the Helmholtz equation with first order absorbing boundary condition in two and three dimensions. We prove that the proposed HDG methods are stable (hence well-posed) without any mesh constraint. The stability constant is independent of the polynomial degree. By using a projection-based error analysis, we also derive the error estimates in L_2 norm for piecewise polynomial spaces with arbitrary degree. This is joint work with Wujun Zhang from University of Maryland.

An Uzawa method for solving steady Navier-Stokes equations discretized by mixed element methods

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Numerical solutions of Navier-Stokes equations play fundamental roles in scientific computing and fluid dynamics. The need to do this frequently occurs in many applied sciences. Mixed element methods are widely used for discretizing steady Navier-Stokes equations in applications. However, it is challenging to devise fast solvers for the resulting nonlinear system. A typical solver involves numerical solution of the discretized Oseen equations at each iteration step; or equivalently, a non-symmetric saddle point system must be solved at each iteration step. However, it is by no means trivial to solve such a subproblem efficiently.

In this talk, we are going to design an Uzawa-type iterative method for the previous nonlinear system, for which we require to solve no saddle point system at each iteration step. Under some reasonable conditions, we prove its convergence rate is independent of the finite element mesh size h, even for the shape regular triangulation. Finally, we provide a series of numerical experiments to show the accuracy and performance of the method proposed. This is a joint work with Puyin Chen and Huashan Sheng.

Semi-classical limit for the Schrödinger equation with lattice potential, and band-crossing

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In this talk, I am going to present the derivation of the semi-classical limit of the Schrödinger equation with lattice potential, where the lattice constant and the Planck constant are at the same order. Bloch theory is used to decompose the solution into eigenfunctions. Here we encounter two problems: 1. eigenvalues degenerate, when this happens one cannot distinguish the associated eigenfunctions, and the so called transition rate between energy bands should be introduced; 2. the evolution of the projection coefficients follow a coupled integro-differential equation, which can be hard to compute. By carrying out the Wigner transformation of all the Bloch bands, we find a complete basis on the phase space. The coefficients for them are controlled by a simple hyperbolic equation, and the transition rates at the point of the degeneracy are characterized explicitly. A domain decomposition method based on the distances between energy bands is designed associated to this newly developed model. This is a joint work with Lihui Chai and Shi Jin.

Legendre pseudospectral method for solving three-dimensional non-linear hyperbolic partial differential equations

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In this talk, numerical solutions of three-space non-linear hyperbolic partial differential equations will be presented by using Legendre pseudospectral method. The discretization of the spatial derivatives of the problem have been solved by using Legendre pseudospectral method. A system of non-linear ordinary differential equations is generated. The values of unknown function u can be found by using kronecker product. The representation of this kind of product can easily be extended to higher dimensions. The numerical results are obtained and compare with exact solutions to validate the high precision of the Legendre pseudospectral method [1-6].

Efficient duality method to a class of global optimizations problems with nonconvex objective function

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In this talk, the speaker presents a comprehensive review and some important developments on the canonical duality theory for solving a broad classes of minimization problem with nonconvex objective function. These problems arise in many real-world applications. By using the canonical dual transformation, the nonconvex primal problem can be converted into a canonical dual problem (i.e., either a concave maximization or a convex minimization problem) with zero duality gap. The idea and the method presented in this talk can be generalized to solve many other difficult problems in nonconvex mechanics, network communication, and scientific computations.

Math and gaming

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Math is indispensable and fundamental in computer video games. Relationship between Math and game development is briefed. Computer video game classification, computer programming languages for creating computer video games and some game API's (Application Programming Interfaces) and engines or libraries are introduced. Gaming elements related to Math are identified. The Cartesian coordinates in Math and the Screen Coordinate System in gaming are compared. The "Dark GDK" Library is used to demonstrate how to draw basic shapes and create interactive video games. Sample C++ programs and their results are shown for developing video games using "DarkGDK", from basic 2-D shapes to interactive video games.

Full Eulerian finite element methods for fluid-structure interaction problem in fictitious domain and phase field approaches

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In this talk we will present a full Eulerian model for a dynamic fluid-structure interaction (FSI) problem by means of Lagrange multiplier/fictitious domain approach and phase field formulation, and design its full Eulerian finite element discretization and effective iterative method. In the fictitious domain approach, the fluid domain and computational mesh are fixed by extending the fluid to the structural domain, and the FSI interfacial conditions are reinforced by Lagrange multiplier. Thus an interpolation technique is needed to interpolate the fluid variables into the structural domain. We also demonstrate a method to deal with the incompressible fluid-compressible structure interaction problem with fictitious domain approach.

In the second approach-phase field formulation, the derived full Eulerian FSI model effectively demonstrates the interaction between fluid flow and solid structure in terms of an uniform system of governing equations defined in a single domain, thus the computational grid is fixed, and the re-meshing and interpolation techniques which are always required by other FSI modeling approaches are no longer needed here. A stabilized solution skill is developed to effectively solve the Euler equation which is essentially the Eulerian description of solid motion for the incompressible hyperelastic material. Numerical experiment is carried out for a cross spinning around its central axis due to the passing flow field, and the numerical results dramatically show the spinning motion of the cross due to the interaction with the fluid, showing that our model and numerical methods are effective to simulate the dynamic fluid-structure interaction phenomena.

Linear numerical schemes for epitaxial thin film growth model

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A few linear schemes for nonlinear PDE model of thin film growth model without slope selection are presented in the talk. In the first order linear scheme, the idea of convex-concave decomposition of the energy functional is applied, and the particular decomposition places the nonlinear term in the concave part of the energy, in contrast to a standard convexity splitting scheme. As a result, the numerical scheme is fully linear at each time step and unconditionally solvable, and an unconditional energy stability is guaranteed by the convexity splitting nature of the numerical scheme. To improve the numerical accuracy, a second order temporal approximation for the nonlinear term is recently reported, which preserves an energy stability. To solve this highly non-trivial nonlinear system, a linear iteration algorithm is proposed, with an introduction of a second order artificial diffusion term. Moreover, a contraction mapping property is proved for such a linear iteration. As a result, the highly nonlinear system can be decomposed as an iteration of purely linear solvers. Some numerical simulation results are also presented in the talk.

Application of MILP to solve complex scheduling problems

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This talk describes the role of mixed integer linear programming (MILP) in solving scheduling problems in complex production processes such as reentrant flexible job shops (RFJS). We modeled such scheduling problems by using several different MILP models. The first model was based on the traditional way of MILP modeling, which denotes the machines, workstations, jobs, operations, and the time slots that arrange the operations on each machine. The second model improved the efficiency of the traditional design by reducing the variable for machines through the relationship between machines and operations. The third model further and significantly reduced the computational complexity of the second model by utilizing the relationship between jobs on the same machine to replace the role of time slots, which were commonly used in previous studies. Accordingly, the improved model can obtain the solution for RFJS problems with dozens of jobs whereas the traditional model, in most cases, is unable to obtain even a feasible solution for the same problems.

Efficient numerical method for boundary conditions of kinetic equations

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In this talk we present a new algorithm based on Cartesian mesh for the numerical approximation of the kinetic models on complex geometry boundary. Due to the high dimensional property, numerical algorithms based on unstructured meshes for a complex geometry are not appropriate. Here we propose to adapt the inverse Lax-Wendroff procedure, which was recently introduced for conservation laws [1], to the kinetic equations. We first apply this algorithm for Boltzmann type operators (BGK, ES-BGK models) in $1D \times 3D$ and $2D \times 3D$ [2]. Then we extend a similar method to bacterial chemotaxis models [3], which is a coupling problem of kinetic equation and parabolic equation. Numerical results illustrate the accuracy properties of these algorithms.

[1] S. Tan and C.-W. Shu, *Inverse Lax-Wendroff procedure for numerical boundary conditions of conservation laws*, Journal of Computational Physics, 229 (2010), 8144-8166.
[2] F. Filbet and C. Yang, *Inverse Lax-Wendroff method for boundary conditions of Boltzmann equations*, Journal of Computational Physics, accepted.
[3] F. Filbet and C. Yang, *Numerical Simulations of Kinetic Models for chemotaxis*, submitted.

MD simulations for motions of evaporative droplets driven by thermal gradients

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The driving mechanism of fluid transport at nanoscale is one of the key problems on the design of micro- and nanofluidic devices. We performed molecular dynamics simulations to study the motions of evaporative droplets driven by thermal gradients along nanochannels. The effect of droplet size and the effect of the co-existent fluid temperature on the motions of droplets are investigated. Our simulation results are in semi-quantitative agreement with the prediction of the continuum model (Xu and Qian 2012 Phys. Rev. E 85 061603). It is found that the droplet mobility is inversely proportional to a dimensionless coefficient associated with the total rate of dissipation due to droplet movement. Our results show that this coefficient is of order unity and increases with the droplet size for the small droplets ($\sim 10nm$). Through a theoretical analysis on the size of the thermal singularity, it can be shown that the droplet mobility decreases with decreasing coexistence temperature. This is also observed in our MD simulations.
This is a joint work with Xinpeng Xu and Tiezheng Qian from HKUST.

Calculating areas and volumes with rotated axis

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Finding areas under a curve and volumes of solid of revolutions are standard applications of definite integrals in a Calculus class. Conventional examples in calculus textbooks use the regular Cartesian coordinate system with vertical and horizontal axes. We explore in this research the problem of calculating areas and volumes when the axis is rotated, and use basic tools from geometry and linear algebra to formulate the corresponding definite integrals. We present some insights as well as difficulties encountered in setting-up the integrals, and in evaluating them analytically or numerically using graphing calculators or online math tools.

Inversion of geothermal heat flux in a thermo-mechanically coupled Stokes ice sheet model

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Modeling the dynamics of polar ice sheets is critical for projection of future sea level rise. Yet, there remain large uncertainties in the basal boundary conditions (e.g., geothermal heat flux) of the ice sheet. Here we target the inversion of the basal geothermal heat flux using surface velocity measurements. The flow of ice sheets and glaciers is modeled as a sheer thinning, viscous incompressible fluid with temperature-dependent viscosity via a thermomechanically coupled Stokes model. The inverse problem is formulated as a nonlinear least-squares optimization problem with a cost functional that contains the misfit between surface velocity observations and model predictions and a Tikhonov regularization term to render the problem well-posed. We use an adjoint-based inexact Newton method for the solution of this least squares optimization problem. Results for 2-D and 3-D model problems demonstrate the ability of inverting for a smoothly varying geothermal heat flux in cold ice regions. This capability will be incorporated into a state-of-the-art continental-scale ice sheet dynamics model.

Modelling of temperature and pricing weather derivatives: a comparison for mainland China

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Temperature-based weather derivatives are a promising financial instrument to hedge weather risk. In most mature financial markets of the world, weather derivatives are traded for several years now. However in Mainland China, such a market does not exist yet. To make the launch of such instruments possible, multi-regional research is needed to find the most suitable temperature model for Mainland China. The contribution of this paper is to compare the performance of several up-to-date temperature models to data from twelve cities from all climatic zones in China. The models are compared in terms of fitting the daily average temperature, normality of residuals, simulation errors and model risk when used for pricing futures and options. The comparison includes a model with monthly contant volatility (Alaton et al, 2002), with daily volatility (Benth et al, 2007), a model with stochastic volatility like proposed by Benth and Benth (2011) and a model using a Spline approach for surface modelling similar to Schiller et al (2012). This is the first paper on multi-regional temperature modelling and weather derivatives pricing using such a large number of cities in a comparison of different models in Mainland China.

Contributed Talks Group 5
Differential Equations

Nonlinear impulsive differential equations arising from chemotherapeutic treatment

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We prove the existence of periodic solutions of systems of nonlinear impulsive differential equations arising from chemotherapeutic treatment for cancer. Our analysis is based on Mawhin's continuation theorem of coincidence degree theorem.

Analysis of some nonlinear PDEs from multi-scale geophysical applications

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This talk is regarding PDE systems from geophysical applications with multiple time scales, in which linear skew-self-adjoint operators of size 1/epsilon gives rise to highly oscillatory solutions. Analysis is performed in justifying the limiting dynamics as epsilon goes to zero; furthermore, the analysis yields estimates on the difference between the multiscale solution and the limiting solution. We will introduce a simple yet effective time-averaging technique which is especially useful in general domains where Fourier analysis is not applicable.

Some piston problems in fluid dynamics

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The piston problem is analyzed from the mathematical point of view. Some features and phenomena caused by the motion of the piston are revealed. We discuss some piston problems for both classical Euler equations and relativistic Euler equations of compressible fluids. In particular, we focus on strong shock front solutions.

Over-compressive shock profile associated with a simplified system from MHD

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In this talk, we present the wave propagation around an over-compressive shock profile with large amplitude for a simplified system from MHD, which is a rotationally invariant system of viscous conservation laws. We show that the solution converges pointwise to another over-compressive profile exponentially, when the perturbations of the initial data to a given profile are sufficiently small. We also give the explicit structure of the solution for the linearized system. The approach begins with an extraction of non-decaying component stacked at the shock front, followed by an iterated approximation process for the remainder. This sharp estimate is strong enough to study the nonlinear problem and conclude the stability of profile.
This is a joint work with Professor Shih-Hsien Yu.

Global stability of E-H type regular refraction of shocks on the interface between two media

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In this talk I will discuss the refraction of shocks on the interface for 2-d steady compressible flow. Particularly, the class of E-H type regular refraction is defined and its global stability of the wave structure is verified. The 2-d steady potential flow equations is employed to describe the motion of the fluid. The stability problem of the E-H type regular refraction can be reduced to a free boundary problem of nonlinear mixed type equations in an unbounded domain. The corresponding linearized problem has similarities to a generalized Tricomi problem of the linear Lavrentiev-Bitsadze mixed type equation, and it can be reduced to a nonlocal boundary value problem of an elliptic system. The latter is finally solved by establishing the bijection of the corresponding nonlocal operator in a weighted Hölder space via careful harmonic analysis.
This is a joint work with CHEN Shuxing and HU Dian.

Multiplicity of positive solutions for a p-q-Laplacian equation with critical nonlinearities

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In this talk, we study the effect of the coefficient $f(x)$ of the critical nonlinearity on the number of positive solutions for a p-q-Laplacian equation. Under suitable assumptions for $f(x)$ and $g(x)$, we should prove that for sufficiently small $\lambda > 0$, there exist at least k positive solutions of the following p-q-Laplacian equation

$$-\Delta_p u - \Delta_q u = f(x)|u|^{p^*-2}u + \lambda g(x)|u|^{r-2}u \text{ in } \Omega,$$

$$u = 0 \text{ on } \partial\Omega,$$

where $\Omega \subset \mathbf{R}^N$ is a bounded smooth domain, $N > p$, $1 < q < \frac{N(p-1)}{N-1} < p \leq \max\{p, p^* - \frac{q}{p-1}\} < r < p^*$, $p^* = \frac{Np}{N-p}$ is the critical Sobolev exponent and $\Delta_s u = div(|\nabla u|^{s-2}\nabla u)$ is the s-Laplacian of u.

The linear hyperbolic initial boundary value problems in a domain with corners

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In this article, we consider linear hyperbolic Initial Boundary Value Problems (IBVP) in a rectangle in both the constant and variable coefficients cases. We use semi-group method instead of Fourier analysis to achieve the well-posedness of the linear hyperbolic system, and we find by diagonalization that there are only two simple modes in the system which we call hyperbolic and elliptic modes. The hyperbolic system in consideration is either symmetric or Friedrichs-symmetrizable.

On quasilinear elliptic equations with variable exponents

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We study the following elliptic equations with variable exponents

$$-\mathrm{div}(\phi(x, |\nabla u|)\nabla u) = \lambda f(x, u) \quad \text{in } \Omega$$

which is subject to Dirichlet boundary condition. Under suitable conditions on ϕ and f, employing the variational methods, in particular, mountain pass theorem and fountain theorem, we establish the existence of nontrival solutions for a class of quasilinear elliptic problems with variable exponents. Also we show the existence of positivity of the infimum of all eigenvalues for the above problem.

Overdetermined boundary value problems with strongly nonlinear elliptic PDE

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We consider the strongly nonlinear elliptic Dirichlet problem in a connected bounded domain, overdetermined with the constant Neumann condition $F(\nabla u) = c$ on the boundary. Here F is convex and positively homogeneous of degree 1, and its polar F^* represents the anisotropic norm on R^n. We prove that, if this overdetermined boundary value problem admits a solution in a suitable weak sense, then Ω must be of Wulff shape.

Stability of boundary layers for the non-isentropic compressible circularly symmetric 2D flow

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In this paper, we study the asymptotic behavior of the circulary symmetric solution to the initial boundary value problem of the compressible non-isentropic Navier-Stokes equations in a two-dimensional exterior domain with impermeable boundary condition when the viscosities and the heat conduction coefficient tend to zero. By multiscale analysis, we obtain that away from the boundary the compressible non-isentropic viscous flow can be approximated by the corresponding inviscid flow, and near the boundary there are boundary layers for the angular velocity, density and temperature in the leading order expansions of solutions, while the radial velocity and pressure do not have boundary layers in the leading order. The boundary layers of velocity and temperature are described by a nonlinear parabolic coupled system. We prove the stability of boundary layers and rigorously justify the asymptotic behavior of solutions in the $L^\infty-$norm for the small viscosities and heat-conduction limit in the Lagrangian coordinates, as long as the strength of the boundary layers is suitably small. Finally, we show that the similar asymptotic behavior of the small viscosities and heat conduction limit holds in the Eulerian coordinates for the compressible non-isentropic viscous flow.

Dynamics in immune reactions during wound healing processes

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We propose a partial differential equation model adapted from the principles of wound healing studies and analyze it to gain insights regarding the dynamics of immune cells/proteins following the insertion of a foreign body. Specifically we look at the multiple roles of macrophages and the conditions for stabilizing/destabilizing the equilibrium state. Furthermore, we investigate the impact of diffusion and chemotaxis on the stability and the transient behavior of the system.

On the radiation field for wave equations

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Definitions for the radiation field by Lax-Phillips and Friedlander are introduced for standard wave equation on Minkowski space-time, which can be generalized to curved space-time (such as Schiwarzschild space-time) and nonlinear wave equations (such as Einstein vacuum equations). Regularities of the radiation field are studied. Mapping property for Moller wave operator, which maps initial data to the radiation field, are investigated. In the case that the Molloer wave operator is an (or a local) isomorphism, the characteristic initial problem is considered.

Relationship between ω-limit Sets and Minimal Sets

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In this paper, we study the relation between ω-limit sets and minimal sets. It is known that every minimal set is a ω-limit set. However, not every ω-limit set is a minimal set, although it contains a minimal set. We would like to know under what condition an ω-limit set turns out to be a minimal set. We establish a necessary and sufficient condition under which every ω-limit set is minimal.

The regularity of semi-hyperbolic patches at sonic lines for the pressure gradient equation in gas dynamics

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We study the uniform regularity of semi-hyperbolic patches of self-similar solutions near sonic lines to a general Riemann problem for the pressure gradient equation. This type of solutions, in which one family of characteristics starts on a sonic line and ends on a transonic shock wave, is common for the Riemann problems for the Euler system in two space dimensions. The global existence of smooth solutions was established in Song and Zheng(2009), but the smoothness near the sonic lines is not clear. We establish that the smooth solutions are uniformly smooth up to their sonic boundaries and the sonic lines are C^1 continuous.

Constructing global Lyapunov function for complex systems

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Lyapunov function, as one of the most significant concepts in dynamical systems, has been widely applied in many disciplines. However, the classical Lyapunov function in the theory of ordinary differential equations are usually restricted to the analysis of the stability near the equilibriums of the system, and no general constructive method has been found. Thus, it cannot be applied to more complex dynamical behaviors, such as multi-stable states, periodic attractor like limit cycle, and chaos. Recently, a series of works based on the construction of potential function in physics for stochastic dynamical process demonstrate potential function plays a critical role in the quantitative analysis of dynamical systems. In deterministic cases, the potential function is the Lyapunov function globally constructed for the systems. In this talk, we first present a novel numerical constructive method on the Lyapunov function for a wide series of dynamical systems. Then, we apply this method in some famous examples, such as the Van Der Pol oscillator and Lorenz system. On the other hand, we analytically construct the Lyapunov function in a chaotic system and the competitive Lotka-Volterra systems. The structure of the attractors, such as fractal, are demonstrated clearly by the Lyapunov function.

The half line versus finite domain problems of the Modified Buckley-Leverett equation

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Buckley-Leverett (MBL) equation describes two-phase flow in porous media. The MBL equation differs from the classical Buckley-Leverett (BL) equation by including a balanced diffusive-dispersive combination. The dispersive term is a third order mixed derivatives term, which models the dynamic effects in the pressure difference between the two phases. The classical BL equation gives a monotone water saturation profile for any Riemann problem; on the contrast, when the dispersive parameter is large enough, the MBL equation delivers non-monotone water saturation profile for certain Riemann problems as suggested by the experimental observations. In this talk, we show that the solution of the finite interval $[0, L]$ boundary value problem converges to that of the half-line $[0, +\infty)$ boundary value problem expoentially fast for the MBL equation as $L \to +\infty$. (This is a joint work with Chiu-Yen Kao.)

Blowup of classical solutions to the compressible Navier-Stokes equations

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In this talk, we present our recent results on the finite time blow up of smooth solutions to the Compressible Navier-Stokes system. We prove that any classical solutions of viscous compressible fluids without heat conduction will blow up in finite time, as long as the initial data has an isolated mass group (see definition in the paper). The results hold regardless of either the size of the initial data or the far fields being vacuum or not. This improves the blowup results of Xin (1998, CPAM) by removing the crucial assumptions that the initial density has compact support and the smooth solution has finite total energy. Furthermore, the analysis here also yields that any classical solutions of viscous compressible fluids without heat conduction in bounded domains or periodic domains will blow up in finite time, if the initial data have an isolated mass group satisfying some suitable conditions.

Stability of supersonic contact discontinuities for three dimensional compressible steady Euler flows

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In this talk, we discuss the nonlinear structural stability of supersonic contact discontinuities in three dimensional compressible isentropic steady Euler equations. We obtain a necessary and sufficient condition for the linear stability of supersonic planar contact discontinuities and a priori estimates of solutions to the linearized problem. The weak stability of this contact discontinuity also results in a loss of regularity with respect to the source terms in the interior domain and on the boundary in the a priori estimates of solutions to the linearized problem. Contact discontinuities with tangential velocity fields on two sides of the discontinuous front parallel or non-parallel are both considered. Moreover, using the calculus of paradifferential operators and taking advantage of the control of non-characteristic components of unknowns by the equations and the problems satisfied by vorticities of velocity fields, we get estimates of high order derivatives of solutions to the linearized problem of a non-planar contact discontinuity. As there is a loss of regularity in the estimates of solutions to the linearized problem, we adapt the Nash-Moser-Hörmander iteration scheme to obtain the nonlinear stability of supersonic contact discontinuities in three dimensional compressible isentropic steady Euler equations. This is a joint work with Ya-Guang Wang.

Global structure of admissible BV solutions to strictly hyperbolic conservation laws in one space dimension

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In [1], we describe the qualitative structure of an admissible BV solution to a strictly hyperbolic system of conservation laws whose characteristic families are piecewise genuinely nonlinear. More precisely, we prove that there are a countable set of points Θ and a countable family of Lipschitz curves $\mathcal{T}$ such that outside $\mathcal{T} \cup \Theta$ the solution is continuous, and for all points in $\mathcal{T} \setminus \Theta$ the solution has left and right limit. This extends the corresponding structural result in [2] for genuinely nonlinear systems. The proof is based on the introduction of subdiscontinuities of a shock, whose behavior is qualitatively analogous to the discontinuities of the solution to genuinely nonlinear systems. An application of this result is the stability of the wave structure of solution w.r.t. L^1_{loc}-convergence. Also a remark on the generalization of the results of general strictly hyperbolic conservation laws will be given.

[1] S. Bianchini and L. Yu, Global structure of admissible BV solutions to piece- wise genuinely nonlinear, strictly hyperbolic conservation laws in on space di- mension. *To appear on Comm. Partial Differential Equations (arXiv:1211.3526)*, 2012.

[2] A. Bressan and P. G. LeFloch, Structural stability and regularity of entropy solutions to hyperbolic systems of conservation laws, *Indiana Univ. Math. J.*, 48 (1999), pp. 43–84.

Contributed Talks Group 6
Probability and Statistics

Estimates of Itô integral and applications to random dynamical systems

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This paper obtains two estimates of Itô integral and their stochastic Gronwall's inequalities, which present an ultimate way to deal with almost sure estimates for stochastic (partial) differential equations with white noises of any type. As examples, they are applied to present a formula estimating the Hausdorff dimensions of the tempered compact random invariant sets and investigate the existence and the Hausdorff dimensions of random attractors for a stochastic wave equation with noisy damping.

Data fusion based on evidence theory

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Data fusion techniques integrate data from multiple sources (such as sensors, institutions, and etc.), and the combined information can help to reach more accurate and more specific inference. In this presentation, evidence theory based combination approaches are introduced to combine distinct sources of uncertain information. The uncertainty in each source of information is represented by a belief function individually, which are then combined to produce a single belief function representing information from all the sources. The approaches are illustrated with examples.

The generalized Itô-Wentzell formula for Itô's process and the stochastic first integral

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We present the Generalized Itô-Wentzell formula, which is the generalization of Itô-Wentzell formula for a multidementional Itô's process with the Wiener and the Poisson perturbations.

This result allowed to set equations for the stochastic first integrals of a stochastic differential equations system.

An explicit cross entropy scheme for mixtures

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The key issue in importance sampling is the choice of the alternative sampling distribution, which is often chosen from the exponential tilt family of the underlying distribution. However, when the problem exhibits certain kind of nonconvexity, it is very likely that a single exponential change of measure will never attain asymptotic optimality and may lead to erroneous estimates. In this paper we introduce an explicit iterative scheme which combines the traditional cross-entropy method and the EM algorithm to find an efficient alternative sampling distribution in the form of mixtures. We also study the applications of this scheme to option price estimation.

Asymptotic analysis for tipping points problems

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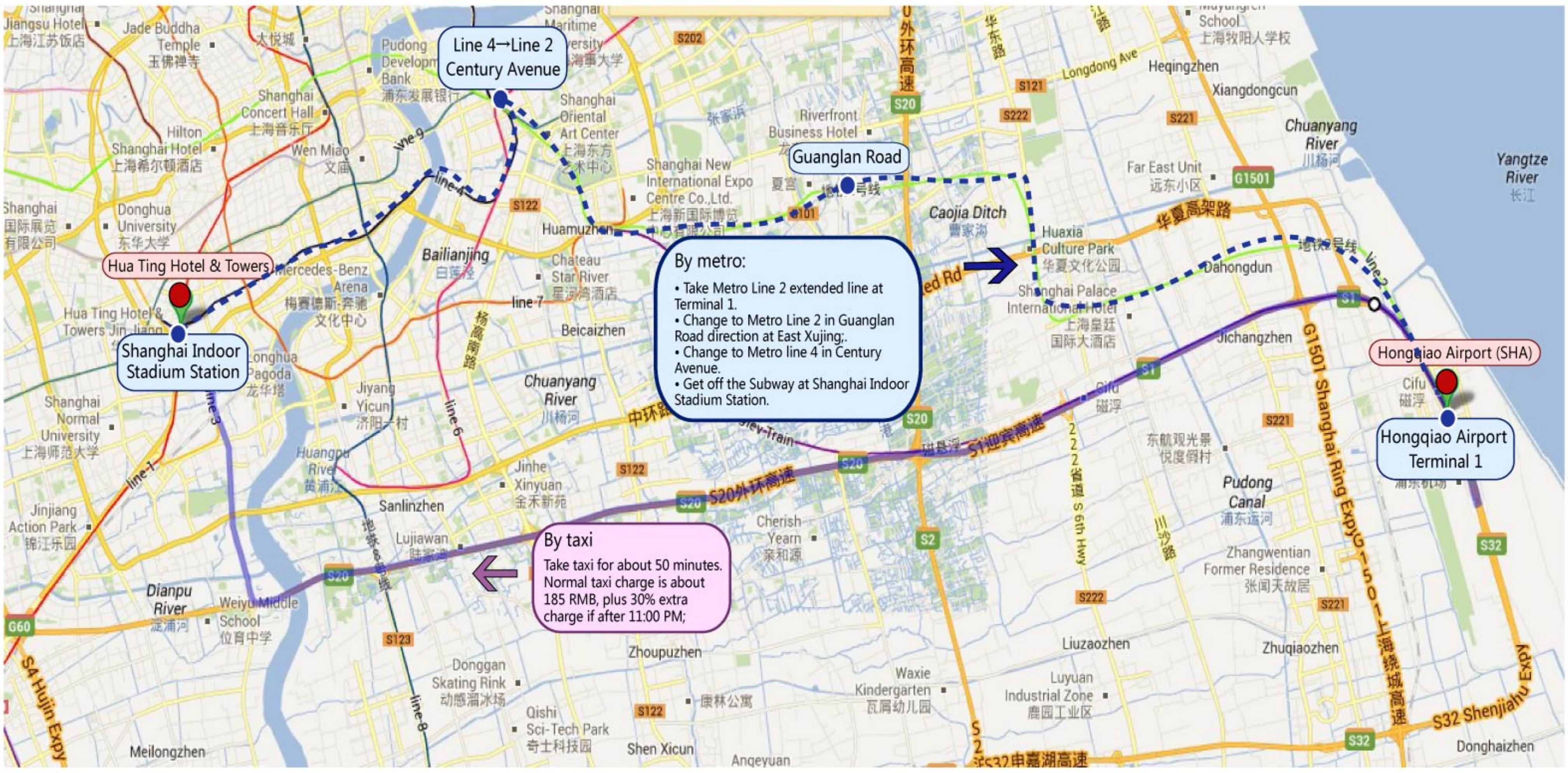
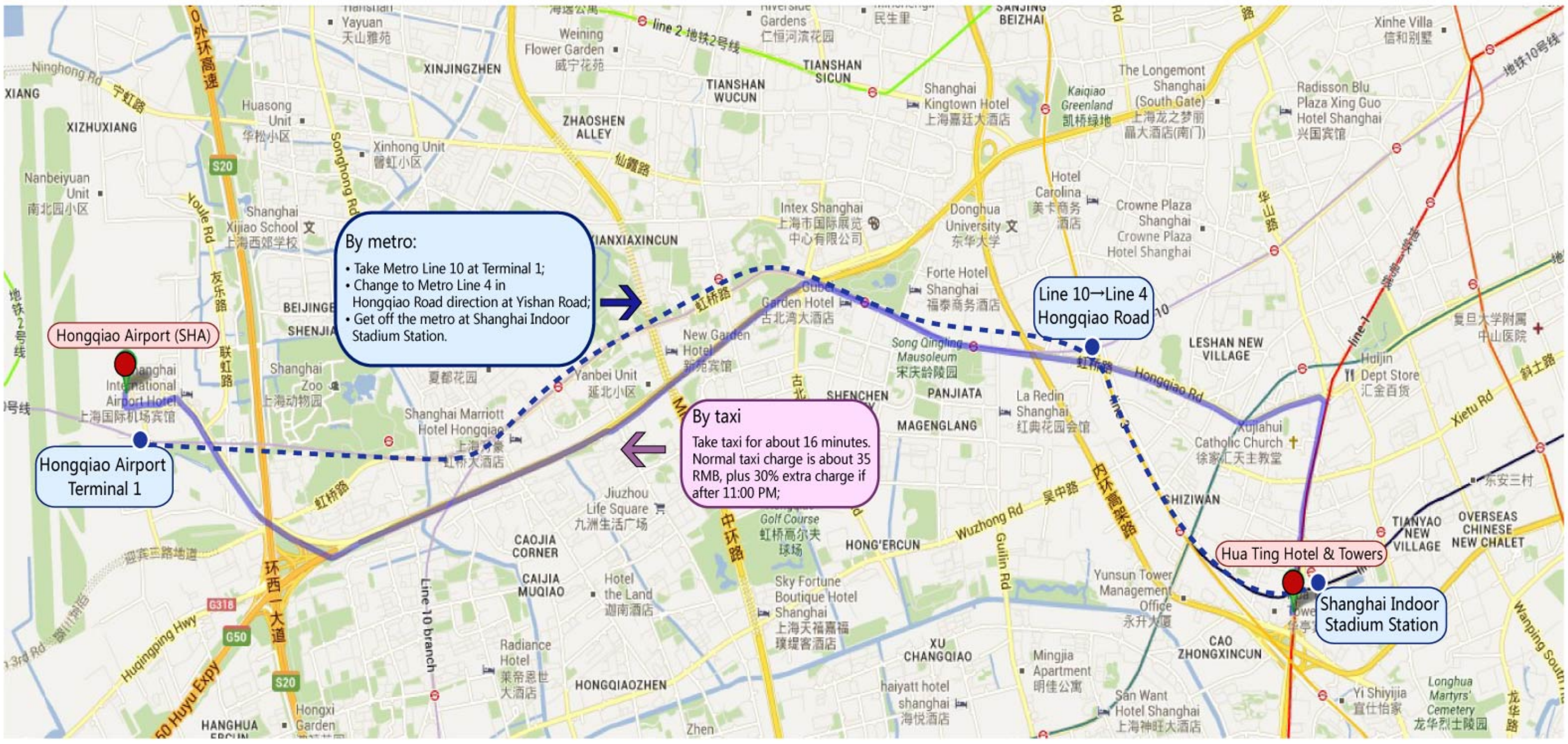
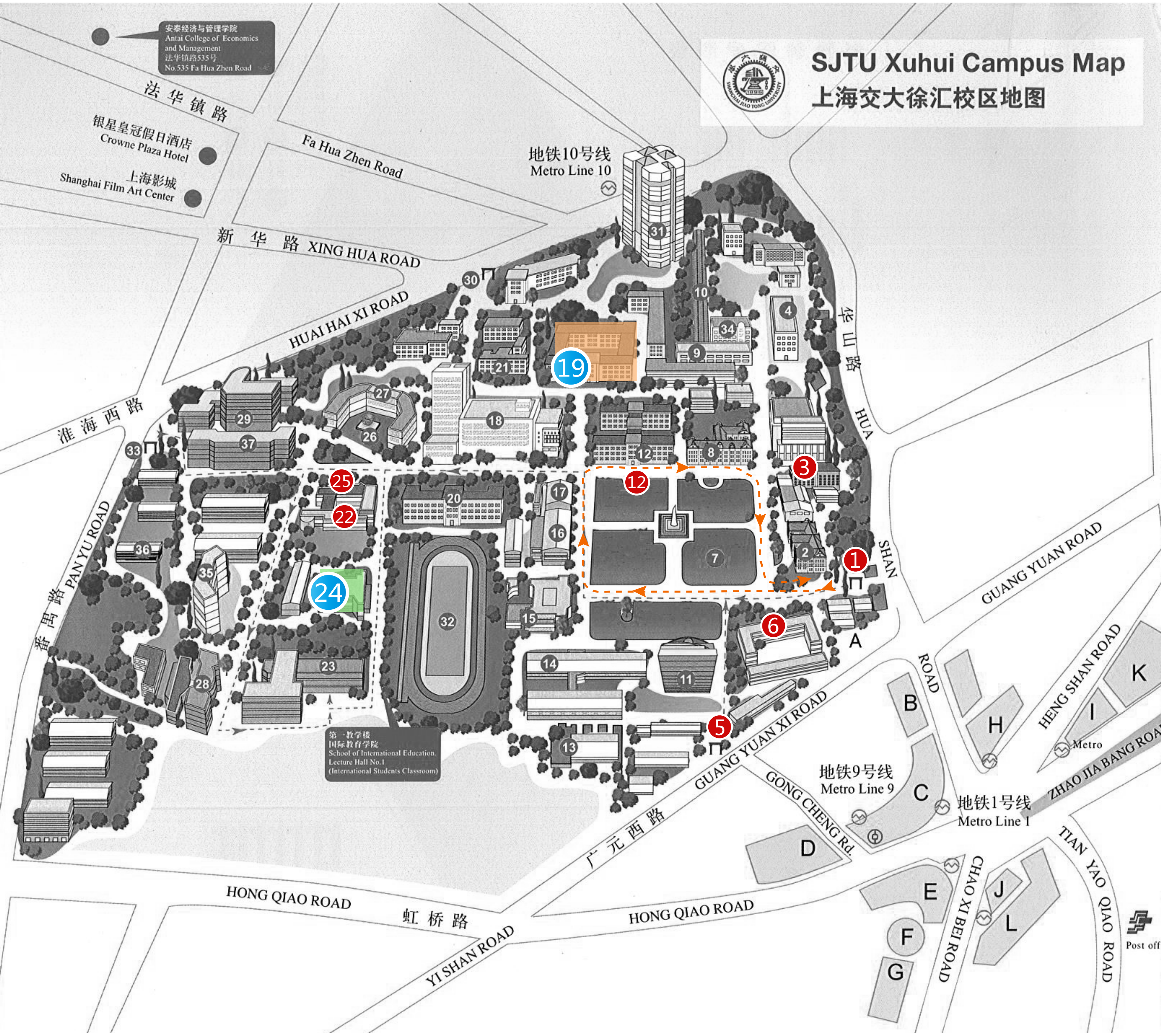
A tipping point, observed as a rapid change in climate or ecology, can be induced by a slowly varying control parameter of a saddle-node bifurcation. The position of the tipping point can be significantly changed by small noise or periodic terms. A local multiple scaling method is used to describe the behaviour of the system based on the relation of the drifting rate, noise and frequency of the periodic terms. A one-dimensional canonical slowly varying system with a saddle-node bifurcation is analysed, to find out the effect of the noise or the frequency of the periodic terms separately. We also show results for a global energy balance model in climate dynamics.



From Pudong International Airport (PVG) to Hua Ting Hotel & Towers



From Hongqiao Airport (SHA) to Hua Ting Hotel & Towers



1	1号门 华山路1954号	进口、出口	Entrance 1954 Hua Shan Road	Entrance/Exit
3	教师活动中心	午休	Faculty Club	Lunch Break
5	5号门 广元西路55号	进口、出口	Main Entrance 55 Guang Yuan Xi Road	Entrance/Exit
6	校医院	医疗救护	School Hosptial	Health Service
19	工程馆	分会场	Engineering Hall	23 Sessions/Contributed Talks/Registration
12	新上院	停靠点	Xin Shang Yuan	Parking lot
22	ATM取款机	银行服务	ATM	ATM
22 25	餐 厅	午餐	Canteen	Lunch
24	文治堂	主会场	Wen Zhi Hall	Public & Plenary Lectures/Opening

Engineering Hall Floor Plan 1F

Wash Room
Book Exhibition
Meeting Room
Tea Break

Engineering Hall Floor Plan 2F