



## **International workshop for kinetic theory**

动理学及其相关领域的研究研讨会

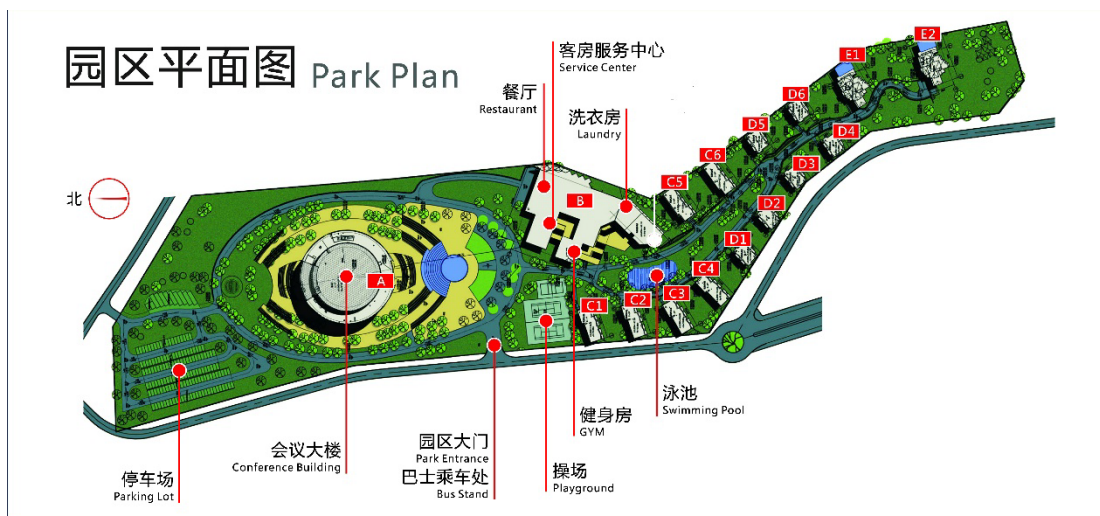
**June 25-29, 2018**

**Welcome to TSIMF**

The facilities of TSIMF are built on a 23-acre land surrounded by pristine environment at Phoenix Hill of Phoenix Township. The total square footage of all the facilities is over 29,000 square meter that includes state-of-the-art conference facilities (over 10,000 square meter) to hold many international workshops simultaneously, two libraries, a guest house (over 10,000 square meter) and the associated catering facilities, a large swimming pool, gym and sports court and other recreational facilities.

Mathematical Sciences Center (MSC) of Tsinghua University, assisted by TSIMF's International Advisory Committee and Scientific Committee, will take charge of the academic and administrative operation of TSIMF. The mission of TSIMF is to become a base for scientific innovations, and for nurturing of innovative human resource; through the interaction between leading mathematicians and core research groups in pure mathematics, applied mathematics, statistics, theoretical physics, applied physics, theoretical biology and other relating disciplines, TSIMF will provide a platform for exploring new directions, developing new methods, nurturing mathematical talents, and working to raise the level of mathematical research in China.

## About Facilities



## Registration

Conference booklets, room keys and name badges for all participants will be distributed at the Registry. Please take good care of your name badge. It is also your meal card and entrance ticket for all events.



## Guest Room



Conference Center can receive about 378 people having both single and double rooms, and 42 family rooms.

All the rooms are equipped with: free Wi-Fi, TV, air conditioning and other utilities.

Family rooms are also equipped with kitchen and refrigerator.



## Library



**Opening Hours: 09:00am-22:00pm**

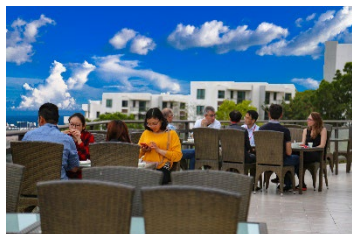
TSIMF library is available during the conference and can be accessed by using your room card. There is no need to sign out books but we ask that you kindly return any borrowed books to the book cart in library before your departure.



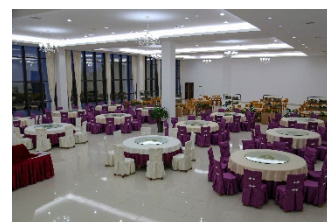
In order to give readers a better understanding of the contributions made by the Fields Medalists, the library of Tsinghua Sanya International Mathematics Forum (TSIMF) instituted the Special Collection of Fields Medalists as permanent collection of the library to serve the mathematical researchers and readers.

So far, there are 210 books from 43 authors in the Special Collection of Fields Medalists of TSIMF library. They are on display in room A220. The participants are welcome to visit.

## Restaurant



All the meals are provided in the Chinese Restaurant (Building B1) according to the time schedule.



<b>Breakfast</b>	<b>07:30-08:30</b>
<b>Lunch</b>	<b>12:00-13:30</b>
<b>Dinner</b>	<b>17:30-19:00</b>



## Laundry

**Opening Hours: 24 hours**

The self-service laundry room is located in the Building 1 (B1).

## Gym

The gym is located in the Building 1 (B1), opposite to the reception hall. The gym provides various fitness equipment, as well as pool tables, tennis tables etc.

## Playground



Playground is located on the east of the central gate. There you can play basketball, tennis and badminton. Meanwhile, you can borrow table tennis, basketball, tennis balls and badminton at the reception desk.

## Swimming Pool

Please note that there are no lifeguards. We will not be responsible for any accidents or injuries. In case of any injury or any other emergency, please call the reception hall at +86-898-38882828.



## Outside Shuttle Service

We have shuttle bus to take participants to the airport for your departure service. Also, we would provide transportation at the Haihong Square (海虹广场) of Howard Johnson for the participants who will stay outside TSIMF. If you have any questions about transportation arrangement, please feel free to contact Ms. Li Ye (叶莉), her cell phone number is (0086)139-7679-8300.

## Free Shuttle Bus Service at TSIMF

We provide free shuttle bus for participants and you are always welcome to take our shuttle bus, all you need to do is wave your hands to stop the bus.



Destinations: Conference Building, Reception Room, Restaurant, Swimming Pool, Hotel etc.



## Contact Information of Administration Staffs

**Location of Conference Affair Office: Room 104, Building A**

Tel: 0086-898-38263896

Technical Support: Mr.Shouxi,HE 何守喜

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**Location of Accommodation Affair Office: Room 200, Building B1**

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**Director of TSIMF**

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Schedule for International workshop for kinetic theory					
Time&Date	Monday	Tuesday	Wednesday	Thursday	Friday
7:30-8:30	<i>Breakfast (60 minutes) settled cannot be changed</i>				
<i>Chair:</i>	Desvillettes	Lingbing He	Tai-Ping Liu	Kazuo Aoki	Stephane Mischler
9:00-9:50	Tai-Ping Liu	Kazuo Aoki	Mario Pulvirenti	Irene Gamba	NOURI Anne
9:55-10:15	<i>Coffee Break (within 30 minutes) settled cannot be changed</i>				
<i>Chair</i>					
10:15-11:05	Xuecheng Wang	Wenjia Jing	Stephane Mischler	Hailiang Li	Kleber Carrapatoso
11:10-12:00	<a href="#">Anton Arnold</a>	Strain, Robert M	Xuguang Lu	Hung-Wen Kuo	Hongjun Yu
12:00-13:30	<i>Lunch (90 minutes) settled cannot be changed</i>				
<i>Chair</i>	Mario Pulvirenti	Anton Arnold		Hailiang Li	Renjun Duan
14:00-14:50	Seung Yeal Ha	Shigeru Takata	Free Discussion 13:30-17:00 (地点三选一: 南山寺 / 天涯海角 / 森林公园)	Bernt Wennberg	Hui Yu
14:55-15:15	<i>Coffee Break (within 30 minutes) settled cannot be changed</i>			<i>Coffee Break (within 30 minutes) settled cannot be changed</i>	
<i>Chair</i>					
15:15-16:05	Sergio Simonella	I-Kun Chen		Kung-Chien Wu	Yuanjie Lei
16:10-17:00	Haitao Wang	Shuangqian Liu		Wei-Xi Li	
17:30	<i>Dinner</i>		Banquet 18:00-20:00	<i>Dinner</i>	

## Titles and Abstracts

1. Kazuo Aoki, Department of Mathematics, National Cheng Kung University and National Center for Theoretical Sciences, National Taiwan University

**Title:** Slip Boundary Conditions for the Compressible Navier–Stokes Equations for a Polyatomic Gas

**Abstract:** The slip boundary conditions for the compressible Navier–Stokes equations for a polyatomic gas are derived from kinetic theory using the ellipsoidal statistical (ES) model of the Boltzmann equation for a polyatomic gas. The analysis, which follows our recent paper for a monatomic gas [K. Aoki *et al.*, *J. Stat. Phys.* **169**, 744–781 (2017)], is based on the Chapman–Enskog expansion and the analysis of the Knudsen layer adjacent to the boundary. The problem of the Knudsen layer is reduced to four basic half-space problems of the linearized ES model, two of which are reduced to the corresponding problems for the Bhatnagar–Gross–Krook (BGK) model for a monatomic gas, and the other two of which are analyzed numerically. The resulting slip boundary conditions are presented with explicit slip coefficients for some typical polyatomic gases. This is a joint work with Masanari Hattori and Shingo Kosuge (Kyoto University).

2. Anton Arnold, Institute of Analysis and Scientific Computing, Vienna University of Technology, A-1040 Wien, Austria

**Title:** Large-time behavior in hypocoercive BGK-models

**Abstract:** BGK equations are kinetic transport equations with a relaxation operator that drives the phase space distribution towards the spatially local equilibrium, a Gaussian with the same macroscopic parameters. Due to the absence of dissipation w.r.t. the spatial direction, convergence to the global equilibrium is only possible thanks to the transport term that mixes various positions. Hence, such models are hypocoercive.

We shall prove exponential convergence towards the equilibrium with explicit rates for several linear, space periodic BGK-models in dimension 1 and 2. Their BGK-operators differ by the number of conserved macroscopic quantities (like mass, momentum, energy), and hence their hypocoercivity index. Our discussion includes also discrete velocity models, and the local exponential stability of a nonlinear BGK-model.

The proof is based, first, on a Fourier decomposition in space and Hermite function decomposition in velocity. Then, the crucial step is to construct a problem adapted Lyapunov functional, by introducing equivalent norms for each mode.

References:

- F. Achleitner, A. Arnold, E.A. Carlen: On linear hypocoercive BGK models; in Springer Proceedings in Mathematics & Statistics, Vol. 126, 2016; p. 1-37.
- F. Achleitner, A. Arnold, E.A. Carlen: On multi-dimensional hypocoercive BGK models; *KRM* 11, 2018; p. 953-1009.



- F. Achleitner, A. Arnold, B. Signorello: On optimal decay estimates for ODEs and PDEs with modal decomposition; to appear 2018.

3. Kleber Carrapatoso, IMAG, Université de Montpellier, France

**Title:** Mean-field limit of the Stokes equation around moving spheres

**Abstract:** In this talk I will present the derivation of a Stokes-Brinkman problem as the mean-field limit of a Stokes equation in  $\mathbb{R}^3$  deprived of  $N$  spheres of radius  $1/N$  with constant boundary conditions), whose centers and boundary conditions are chosen randomly. This is a joint work with M. Hillairet.

4. I-Kun Chen, National Taiwan University, Taiwan.

**Title:** Regularity for diffuse reflection boundary problem to the stationary linearized Boltzmann equation in a convex domain

**Abstract:** We investigate the regularity issue for the diffuse reflection boundary problem to the stationary linearized Boltzmann equation for hard sphere potential, cutoff hard potential, or cutoff Maxwellian molecular gases in a strictly convex bounded domain. We obtain pointwise estimates for first derivatives of the solution provided the boundary temperature is bounded differentiable and the solution is bounded. The key idea is to transfer the regularity in velocity variables obtain by collision and diffuse reflection to space variables by the combination of free transfer and averaging through proper choice of coordinates. This talk is based on a joint work with Chun-Hsiung Hsia and Daisuke Kawagoe.

5. Irene Gamba, University Texas at Austin

**Title:** On the Existence and Uniqueness of a Boltzmann System for Monoatomic Gas mixture and Polyatomic Gas models

**Abstract:** We prove existence and uniqueness of the vector value solution to the Boltzmann system of equation describing multi-component monatomic gas mixtures in a full non-linear setting. This is accomplished by obtaining a global generation and propagation of suitable polynomial and exponential moments associated to the system solution and a the use of an existence theorem for ODE systems in Banach spaces. These methods can be adjusted to rigorously justify the existence and uniqueness for Polyatomic gas models. This is work in collaboration with Milana Pavi-oli.

6. Seung Yeal Ha, Department of Mathematical Sciences, Seoul National University, Seoul, 08826 Korea (Republic of)

**Title: A panoramic View of Collective Dynamics (Mathematician's view)**

**Abstract:** Self-organization of complex many-body systems has received lots of attention in scientific disciplines such as applied mathematics, biology, control theory of multi-agent system, statistical physics due to many recent applications in cooperative robot system, unmanned aerial vehicles such as drones and sensor networks etc.

In this talk, we will discuss recent development and mathematical challenges arising from the study of collective dynamics of classical and quantum many-body systems. In this talk, I will present a recent survey on the mathematical progress of collective dynamics.

7. Hung-Wen Kuo, National Cheng Kung University

**Title:** Effect of abrupt change of the wall temperature in the kinetic theory

**Abstract:** We consider a semi-infinite expanse of a rarefied gas bounded by an infinite plane wall. The temperature of the wall is  $T_0$ , and the gas is initially in equilibrium with density  $\rho_0$  and temperature  $T_0$ . The temperature of the wall is suddenly changed to  $T_w$  at time  $t = 0$  and is kept at  $T_w$  afterward. We study the quantitative short time behavior of the gas in response to the abrupt change of the wall temperature on the basis of the linearized Boltzmann equation. Our approach is based on a straightforward calculation of the exact formulas derived by Duhamel's integral. Our method allows us to establish the pointwise estimates of the microscopic distribution and the macroscopic variables in short time. We show that the short-time solution consists of the free molecular flow and its perturbation, which exhibits logarithmic singularities along the characteristic line and on the boundary.

8. Wenjia Jing, Yau Mathematical Sciences Center, Tsinghua University, Callaghan, Beijing 100084, China

**Title:** Propagation of stochasticity in kinetic related problems

**Abstract:** We consider two model reduction problems that are related to kinetic equations. In the first problem, one starts from (simplified) wave equations in highly heterogeneous media, which is hence modeled as random, and derives kinetic equations for the propagation of wave packages in the larger scale, i.e. much longer than the scale of variations in the media and much longer than the wavelength. In the second problem, one starts from a (linear) kinetic equation with highly heterogeneous (absorption and scattering) coefficients, and characterizes the large-scale effective equation with homogenized coefficients. In both problems, we address the quantification and characterization of the random errors caused by those large-scale model reductions.

9. Yuanjie Lei, Huazhong University of Science and Technology

**Title:** On the Vlasov-Poisson-Boltzmann Limit of the Vlasov-Maxwell-Boltzmann system in the perturbative framework

**Abstract:** We give a rigorous global in time mathematical justification of the limit from the Vlasov-Maxwell-Boltzmann system to the Vlasov-Poisson-Boltzmann system in the perturbative framework for the whole range of cutoff intermolecular interactions as the light velocity parameter  $c$  tends to infinity. In this talk, we will show that, for the global-in-time solutions  $(F_{\pm}^c, E^c, B^c)$  to the Vlasov-Maxwell-Boltzmann system near Maxwellians, as the light velocity parameter  $c$  tends to infinity,  $(F_{\pm}^c, E^c)$  will converge to that of Vlasov-Poisson-Boltzmann system near Maxwellians, while the magnetic field  $B^c$  will converge to any given constant magnetic field including

vacuum magnetic field. Our analysis relies heavily on the expansion with respect to the reciprocal of light speed parameter  $c$  and the structure of Maxwell system.

10. Hailiang Li, Capital Normal Univeristy

**Title:** Behaviors of Navier-Stokes(Euler)-Fokker-Planck equations

**Abstract:** We consider the behaviors of global solutions to the initial value problems for the multi-dimensional compressible Navier-Stokes(Euler)-Fokker-Planck equations. It is shown that due the micro-macro coupling effects, the sound wave type propagation of this NSFP or EFP system for two-phase fluids is observed with the wave speed determined by the two-phase fluids. This phenomena can no be obsered for the pure Fokker-Planck equation.

11. Wei-Xi Li, School of Mathematical and Statistics, Wuhan University, Wuhan 430072, China

**Title:** Gevrey smoothing effect for the spatially inhomogeneous Boltzmann equations without cut-off

**Abstract:** In this talk we present the Gevrey regularization effect for the spatially inhomogeneous Boltzmann equation without angular cutoff. This equation is partially elliptic in the velocity direction and degenerates in the spatial variable. We consider the nonlinear Cauchy problem for the fluctuation around the Maxwellian distribution and prove that any solution with mild regularity will become smooth in Gevrey class at positive time, with Gevrey index depending on the angular singularity. Our proof relies on the symbolic calculus for the collision operator and the global subelliptic estimate for the Cauchy problem of linearized Boltzmann operator.

12. Shuangqian Liu, Department of Mathematics, Jinan University, Guangzhou 510632, P.R. China

**Title:** Compressible Navier-Stokes approximation for the Boltzmann equation in bounded domains

**Abstract:** It is well known that the full compressible Navier-Stokes equations can be deduced via the Chapman-Enskog expansion from the Boltzmann equation as the first-order correction to the Euler equations with viscosity and heat-conductivity coefficients of order of the Knudsen number  $\epsilon > 0$ . In this talk, we carry out the rigorous mathematical analysis of the compressible Navier-Stokes approximation for the Boltzmann equation regarding the initial-boundary value problems in general bounded domains. The main goal is to measure the uniform-in-time deviation of the Boltzmann solution with diffusive reflection boundary condition from a local Maxwellian with its fluid quantities given by the solutions to the corresponding compressible Navier-Stokes equations with consistent non-slip boundary conditions whenever  $\epsilon > 0$  is small enough. Specifically, it is shown that for well chosen initial data around constant equilibrium states, the deviation weighted by a velocity function is  $O(\epsilon^{1/2})$  in  $L_{x,v}^\infty$  and  $O(\epsilon^{3/2})$  in  $L_{x,v}^2$  globally in time. The proof is based on the uniform estimates for the remainder in different functional spaces without any spatial regularity. One key step is to obtain the global-in-time existence as well as uniform-in- $\epsilon$  estimates for

regular solutions to the full compressible Navier-Stokes equations in bounded domains when the parameter  $\epsilon > 0$  is involved in the analysis.

13. Tai-Ping Liu, Institute of Mathematics, Academia Sinica

**Title:** Shock Wave Theory and Boltzmann Equation

**Abstract:** Over the years, the speaker and Shih-Hsien Yu have tried to generalize the techniques in the shock wave theory for the study of the Boltzmann equation. We soon found out that there are similarities and also essential differences between the two fields. Specific examples will be given to illustrate this. We will start with the construction of the Green's function for viscous conservation laws and for the Boltzmann equation. We then proceed with examples on nonlinear waves and boundary phenomena.

14. Xuguang Lu, Tsinghua University

**Title:** Rate of convergence to equilibrium for bosons

**Abstract:** In this talk I will introduce a recent joint work with Shuzhe Cai on the rate of long time strong convergence to equilibrium for solutions of the spatially homogeneous Boltzmann-Nordheim equation for bosons for the hard sphere model. The case of low temperature is included and we obtain a rate of long time convergence to the Bose-Einstein condensation for all isotropic and non-singular initial data satisfying only the low temperature condition. Our proof is based on the entropy control, Villani's inequality for the entropy dissipation, a suitable time-dependent convex combination between the solution and a fixed positive function (in order to overcome the lack of positive lower bound), and an iteration technique for proving the condensation in finite time. The convergence rate we obtained is very slow:  $O(t^{-\alpha})$  ( $t \rightarrow +\infty$ ) with  $\frac{1}{160} < \alpha < \frac{1}{152}$ , but it is the first result on this direction.

15. Stéphane Mischler, Université Paris-Dauphine, France

**Title:** Semigroups, large time behavior, hypodissipativity and weak dissipativity

**Abstract:** We will make an overview on several approaches for establishing the large time asymptotic behavior of semigroups associated to hypodissipative operators coming from kinetic theory of gases and Markov processes theory. We will mainly focus on the weak dissipativity case for which we will establish polynomial and subexponential rates of convergence to the equilibrium. We will illustrate our approaches on the Fokker-Planck equation with subcritical confinement force.

16. Anne Nouri, France

**Title:** Bose condensates in interaction with excitations. A two-component model close to equilibrium

**Abstract:** We consider a model for Bose gases in the so-called high-temperature range below the temperature where Bose-Einstein condensation sets in. The model is of two-component type, consisting of a Gross-Pitaevskii equation for the condensate,

interacting with a gas of excitations, modeled by a linearized quantum kinetic equation. Results on well-posedness and trend to equilibrium are obtained for the system in a periodic H1 setting.

17. Mario Pulvirenti. Department of Mathematics University of Roma, La Sapienza and MEMOCS L'Aquila. e-m pulviren@mat.uniroma1.it

**Title:** Propagation of chaos for a model with topological interaction

**Abstract:** I consider an alignment model with a topological interaction. This is a possible kinetic description arising, for instance, from the study of a large group of birds in a mean-field scaling. Starting from the microscopic dynamics of the multi-agent system, we want to prove propagation of chaos to derive rigorously the kinetic equation which was heuristically found by A. Blanchet and P. Degond. This is a research in collaboration with P. Degond.

18. Sergio Simonella, CNRS & UMPA, École Normale Supérieure, Lyon, France

**Title:** Connectivity of collisions in chaotic systems

**Abstract:** I will discuss how to obtain detailed estimates of correlations in large particle systems, covering simultaneously several types of kinetic models, by means of a common hierarchy of equations. The same hierarchical structure can be used to describe a dynamical phase transition for the number of particles connected by a sequence of binary interactions.

19. Robert.M. Strain, USA

**Title:** TBA

20. Shigeru Takata, Department of Aeronautics and Astronautics, Kyoto University, Kyoto 615-8540, Japan

**Title:** A simple kinetic model for phase transition

**Abstract:** A simple (presumably minimum) kinetic model for the phase transition of the van der Waals fluid is presented. In the model, intermolecular collisions for a dense gas has not been treated faithfully. Instead, the expected interactions as the non-ideal gas effect are confined in a self-consistent force term. Collision term plays just a role of thermal bath. Accordingly, it conserves neither momentum nor energy, even globally. It is demonstrated that (i) by a natural separation of the mean-field self-consistent potential, the potential for the non-ideal gas effect is determined from the equation of state for the van der Waals fluid, with the aid of the balance equation of momentum, (ii) a monotonically decreasing function in time is found from the H theorem and turns out to have a close relation to the Helmholtz free energy in thermodynamics, and (iii) the Cahn–Hilliard type equation is obtained in the continuum limit of the proposed kinetic model. Some numerical simulations will be presented as well. The talk will be based on, in part, Takata & Noguchi, arXiv:1711.01166.

21. Xuecheng Wang, Yau Mathematical Sciences Center, Tsinghua University.

**Title:** Propagation of regularity for the 3D massive relativistic transport equations

**Abstract:** We will talk about the propagation of regularity and the long time behavior of the 3D massive relativistic Vlasov-Wave type coupled systems for small localized initial data. In particular, we don't impose any compact support assumptions on the initial data.

22. Haitao Wang, School of Mathematical Sciences and Institute of Natural Sciences, Shanghai Jiao Tong University

**Title:** Pointwise estimate of the solution of the linearized Boltzmann equation

**Abstract:** We study the pointwise behavior of the solutions of the linearized Boltzmann equation for hard potentials, Maxwellian molecules and soft potentials, with Grad's angular cutoff assumption. More precisely, for solutions inside the finite Mach number region, we obtain the pointwise fluid structure for hard potentials and Maxwellian molecules, and optimal time decay in the fluid part and sub-exponential time decay in the non-fluid part for soft potentials. For solutions outside the finite Mach number region, we obtain sub-exponential decay in the space variable. The singular wave estimate, regularization estimate and refined weighted energy estimate play important roles in the study. This is a joint work with Yu-Chu Lin and Kung-Chien Wu.

23. Bernt Wennberg, Department of Mathematical Sciences, Chalmers University of Technology and the University of Gothenburg, Gothenburg, Sweden

**Title:** A Kac model with an exclusion principle

**Abstract:** The Kac was designed to better understand the link between a particle system dominated by binary interactions, and the corresponding Boltzmann equation. We present here a Kac model with an exclusion principle, imitating a model for Fermions, although without discretizing the state space. We determine the invariant measure for this model; it is chaotic, but not identical to the Fermi-Dirac distribution. We also discuss the dynamics of the model. This is an ongoing work together with Eric Carlen.

24. Kung-Chien Wu, Department of Mathematics, National Cheng Kung University, Tainan, Taiwan

**Title:** Explicit Structure of the Fokker-Planck Equation

**Abstract:** We study the pointwise (in the space and time variables) behavior of the Fokker-Planck Equation with flat confinement. The solution has a very clear description in the  $xt$ -plane, including large time behavior and asymptotic behavior. The regularization estimate in weighted space plays a crucial role in this paper.

25. Hongjun Yu, School of Mathematical Sciences, South China Normal University, Guangzhou 510631, P. R. China. Email: yuhj2002@sina.com

**Title:** The Vlasov-Poisson-Landau System near a local Maxwellian

**Abstract:** In this talk, we discuss about the stability the Vlasov-Poisson-Landau system with the physical Coulomb potential near a local Maxwellian. The macroscopic components of this local Maxwellian are the approximate rarefaction wave of the one dimensional Euler equations. As a byproduct, the nonlinear stability of the same rarefaction waves for the pure Landau equation is also proved. This illustrates in our setting that the electric field does not affect the propagation of rarefaction waves to the Landau equation.

26. Hui Yu, Yau Mathematical Sciences Center, Tsinghua University.

**Title:** Self-Organized Hydrodynamic models for nematic alignment and the application to myxobacteria

**Abstract:** A continuum model for a population of self-propelled particles interacting through nematic alignment is derived from an individual-based model. The methodology consists of introducing a hydrodynamic scaling of the corresponding mean field kinetic equation. The resulting perturbation problem is solved thanks to the concept of generalized collision invariants. It yields a hyperbolic but nonconservative system of equations for the nematic mean direction of the flow and the densities of particles flowing parallel or antiparallel to this mean direction. An application to myxobacteria is presented.

