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 though 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 ρ_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 $(F^c_\pm, E^c, B^c)$ to the Vlasov-Maxwell-Boltzmann system near Maxwellians, as the light velocity parameter c tends to infinity,$(F^c_\pm, E^c)$ 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 $L^\infty_{x,v}$ and $O(\epsilon^{3/2})$ in $L^2_{x,v}$ 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-ϵ 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, Insitute of Mathematics, Academia Sinica

Title: Shock Wave Theory and Boltzmann Equation

Abstract: Over the years, the speaker and Shih-Hsien Yu have tried to generalized 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 convergrnce 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: $O(t^{-\alpha})$ $(t \to +\infty)$ 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 hypodissipatifs 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 multiagent 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 betwen 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 witout discretizing the state space. We determinie 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 toghether 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 play a crucial rule 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.