# Workshop on Analysis and Applications of PDEs

7 – 8 April 2017

Sponsors:
The AMSS-PolyU Joint Research Institute
The Hong Kong Polytechnic University

Organizers:

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| Renjun Duan | The Chinese University of Hong Kong |
| Zhian Wang | The Hong Kong Polytechnic University |
| Tong Yang | City University of Hong Kong |

**Schedule – 7th April 2017 (Friday)**

Venue: Room TU801, 8/F, Core T, Yip Kit Chuen Building, PolyU

| **Time** | **Speaker / Title** |
|---|---|
| 09:25-09:30 | Opening remark |
| *Session Chair* | *Tong Yang* |
| 09:30-10:10 | **Mario Pulvirenti,** Università di Roma La Sapienza<br>From N-Body Schrödinger to Hartree: Uniformity in ħ |
| 10:10-10:30 | Coffee & Tea Break |
| *Session Chair* | *Zhian Wang* |
| 10:30-11:10 | **Yong Jung Kim**, KAIST<br>Advection and cross-diffusion models customized by population dynamics |
| 11:10-11:50 | **Hongjun Yu**, South China Normal University<br>Global solution to the inhomogeneous non-cutoff Kac equation |
| 12:00-14:30 | Lunch |
| *Session Chair* | *Renjun Duan* |
| 14:30-15:10 | **Yoshinori Morimoto**, Kyoto University<br>Generalized Toscani metric and the spatially homogeneous Boltzmann Equation |
| 15:10-15:50 | **Huanyao Wen**, South China University of Technology<br>Global well-posedness of solutions to a drift-flux model |
| 15:50-16:10 | Coffee & Tea Break |
| *Session Chair* | *Huanyao Wen* |
| 16:10-16:50 | **Shuangqian Liu,** Jinan University<br>The Boltzmann equation with weakly inhomogeneous data in bounded domain |
| 16:50-17:30 | **Yong Wang,** Chinese Academy of Sciences<br>The Boltzmann equation with large-amplitude initial data in bounded domains |
| 18:00-20:30 | Banquet |

**Schedule – 8th April 2017 (Saturday)**

Venue: Room TU801, 8/F, Core T, Yip Kit Chuen Building, PolyU

| Time | Speaker / Title |
|---|---|
| *Session Chair* | *Wei Xiang* |
| 09:30-10:10 | **Myoungjean Ba**e, POSTECH<br>Subsonic flow of Euler-Poisson system with nonzero vorticity |
| 10:10-10:50 | **Weiran Sun,** Simon Fraser University<br>Radiative transfer equation with the Heney-Greenstein kernel |
| 10:50-11:00 | Break |
| *Session Chair* | *Xianpeng Hu* |
| 11:00-11:50 | **Haiyang Jin,** South China University of Technology<br>Direct chemotaxis vs. indirect chemotaxis |
| 12:00-14:00 | Lunch |
| 14:00-16:00 | Free Discussion |

**Subsonic flow of Euler-Poisson system with nonzero vorticity**

*Myoungjean Bae*
POSTECH, Korea

**Abstract:** Steady compressible Euler-Poisson system

$$\begin{cases} \mathrm{div}(\rho\mathbf{u}) = 0 \\ \mathrm{div}(\rho\mathbf{u}\otimes\mathbf{u}) + \nabla \mathrm{p} = \rho\nabla\Phi \\ \mathrm{div}(\rho(\mathrm{e}(\mathrm{p},\rho) + \frac{\mathrm{p}}{\rho})\mathbf{u}) = \rho\mathbf{u}\cdot\nabla\Phi \\ \Delta\Phi = \rho - b \end{cases}$$

models various physical phenomena, including the propagation of electrons in sub-micron semiconductor devices and plasmas. Similarly to compressible Euler system, Euler-Poisson system changes its mathematical feature depending on the Mach number $M = \frac{|\boldsymbol{u}|}{c(p,\rho)}$. But, due to a nonlocal and nonlinear effect of electric potential $\Phi$ , one needs a new approach to study subsonic, supersonic or transonic flows of Euler-Poisson system. In this talk, I will discuss on the following subjects:

1. 1-d flows of Euler-Poisson system;
2. tranosnic shock problem;
3. multidimensional subsonic solutions: potential flow, flow with nonzero vorticity.

This talk is based on several joint works with Ben Duan, M. Feldman, Yong Park, Shangkun Weng and Chunjing Xie.

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**Direct chemotaxis vs. indirect chemotaxis**

*Haiyang Jin*
South China University of Technology

**Abstract:** In this talk, we will consider some chemotaxis models with indirect signal production. We show that in contrast to the classical Keller-Segel chemotaxis model reflecting immediate signal secretion by the cells themselves, the indirect mechanism of signal production in chemotaxis model has drastic influence on the solution behavior.

**Advection and cross-diffusion models customized by population dynamics**

*Yong Jung Kim*
KAIST, Korea

**Abstract:** Migration is a survival strategy of a biological species and usually modeled by advection or diffusion. In this paper we derive a few biological advection and diffusion models which are customized by population dynamics. The population dynamics in logistic, Lotka-Volterra type competition and predator-prey equations are considered and the resulting advection and cross-diffusion models turn out to be logarithmic ones. These derivations provide meaningful coefficients regimes.

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**The Boltzmann equation with weakly inhomogeneous data in bounded domain**

*Shuanqian Liu*
Jinan University

**Abstract:** This talk is concerned with the Boltzmann equation with specular reflection boundary condition. We will show how to construct a unique global solution for the Boltzmann equation in bounded domain and obtain its large time asymptotic behavior in the case that the initial data is close enough to a radially symmetric homogeneous datum. This is a joint work with Prof. Y. Guo.

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**Generalized Toscani metric and the spatially homogeneous Boltzmann Equation**

*Yoshinori Morimoto*
Kyoto University, Japan

**Abstract:** From the middle of 1990s, Toscani and his coauthors, analytically, studied the existence, the uniqueness and the asymptotic behavior of solutions to the Cauchy problem for the non-cutoff spatially homogeneous Boltzmann equation of Maxwellian molecules, introducing the so-called Toscani metric defined in the space of the Fourier image of probability measures, motivated by an earlier work of Hiroshi Tanaka (‘78) by means of the probabilistic method. By using the Toscani metric on probability measures with moments less than 2, Cannone-Karch (‘10) studied infinite energy solutions to the above Cauchy problem, which include self-similar solutions given by Bobylev-Cercignani(‘02). In order to establish the existence theory and smoothing effect of measure valued solutions for the non-cutoff homogeneous Boltzmann equation, the Toscani metric was generalized on probability measures with moments less than 2 in a series of joint works with S. Wang and T. Yang. Furthermore, in a recent paper (SIAM J.M.A. ‘16) by Y.-K. Cho and us, the class of probability measures possessing finite moments of an arbitrary positive order is characterized in terms of the symmetric difference operators of their Fourier transforms. In this talk, I state this generalized Toscani metric which is equivalent to the Monge-Kantorovich-Wasserstein metric, and moreover review the existence and smoothing effect of measure valued solutions, including the non Maxwellian molecules case.

### From N-Body Schrödinger to Hartree: Uniformity in ħ

*Mario Pulvirenti*
Università di Roma La Sapienza, Italy

**Abstract:** It is well known that, under the mean-field scaling, the solution of the N-Body Schrödinger equation converge to the solution of the nonlinear Hartree equation. However the rate of convergence is strongly diverging when ħ is vanishing. Since the same result is also valid for classical system (in this case the limiting equation is the Vlasov equation) it is natural to look for estimates independent of ħ. In this talk I review recent progresses in this direction obtained by the author in collaboration with F. Golse and T. Paul.

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### Radiative transfer equation with the Heney-Greenstein kernel

*Weiran Sun*
Simon Fraser University, Canada

**Abstract:** Radiative transfer equation with the Henyey-Greenstein kernel are often used to model the light scattering in a media such as animal tissues. In such models the forward-peakness of the scattering kernel is measured by an anisotropic factor g. It is known in the physics literature that asymptotic behaviour when g goes to 1 is not the classical Fokker-Planck operator. Instead in this talk we show that the limit should be a fractional Laplace operator on the sphere. Based on this analytical result, we design numerical schemes for approximating the scattering operator with the Henyey-Greenstein kernel. Unlike previous results when the mesh size depends on g and have to be refined as g approaches 1, our method is uniform in g. This reduces the computational cost when g is close to 1 and can provide an efficient scheme for solving RTE over the region where g varies in different parts.

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### The Boltzmann equation with large-amplitude initial data in bounded domains

*Yong Wang*
Chinese Academy of Sciences, China

**Abstract:** The paper is devoted to studying the global dynamics of the Boltzmann equation on bounded domains. We allow a class of non-negative initial data which have arbitrary large amplitude and even contain vacuum. The result shows that the oscillation of solutions away from global Maxwellians becomes small after some positive time provided that they are initially close to each other in $L^2$. This yields the disappearance of any initial vacuum and the exponential convergence of large-amplitude solutions to equilibrium in large time. The most key ingredients in our strategy of the proof include: (i) $L^2_{x,v}$--$L^\infty_xL^1_v$--$L^\infty_{x,v}$ estimates along a bootstrap argument; (ii) Pointwise estimates on the upper bound of the gain term by the product of $L^\infty$ norm and $L^2$ norm; (iii) An iterative procedure on the nonlinear term.

**Global well-posedness of solutions to a drift-flux model**

*Huanyao Wen*
South China University of Technology, China

**Abstract:** We shall talk about the global well-posedness of Dirichlet problem for a one-velocity viscous drift-flux model in one dimension. By relying on weak compactness tools we obtain an existence result within the class of weak solutions. An essential novel aspect of this analysis, compared to previous works on the same model, is that the solution space is large enough to allow for transition to single-phase flow without any constraints. This work is joint with Professors Steinar Evje and Changjiang Zhu.

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**Global solution to the inhomogeneous non-cutoff Kac equation**

*Hongjun Yu*
South China Normal University, China

**Abstract:** In this talk, we make use of macro-microscopic decomposition and the energy methods to obtain global solution to the inhomogeneous one-dimension non-cutoff Kac equation. And we analyze the spectrum structure of the linearized Kac equation by using the semi-group theory and the linear operator perturbation theory. Then we employ the spectrum structure of the linearized Kac equation and the semigroup methods to obtain the time decay rate of the nonlinear equation.


Workshop venue:
Room TU801, 8/F., Core T, Yip Kit Chuen Building
The Hong Kong Polytechnic University
香港理工大學
Campus Map
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CHEONG WAN ROAD 暢運道
JOGGING TRACK 緩跑徑
KEITH LEGG SPORTS FIELD
BUS STOP 巴士站
TO MTR HUNG HOM STATION 往紅磡港鐵站
TO MTR JORDAN STATION 往佐敦港鐵站
TO MTR TSIM SHA TSUI EAST STATION 往尖東港鐵站