JSPS/SAC SEMINAR, MARCH 17-18, 2022: ON GAS KINETIC/DYNAMICS AND LIEF SCIENCE

Zoom link: https://chalmers.zoom.us/j/69733567289.
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Program and book of Abstracts

MARCH 17, 9:00-14:15 (Sweden)/17:00-22:15 (Japan)

Opening remarks

9.00-9.05– Director of JSPS Stockholm Office Dr. Tadaharu Tsumoto

9.05-9.10– Professor Bernt Wennberg

9.10-9.15– Professor Imre Pazsit

Presentations (tentativ)

Session 1, 9.15–10.30, (Chair: Professor Kazuo Aoki)

J1: 9.15-10.00– Professor Shigeru TAKATA: Plenary speaker (Kyoto Univ)

Title: *A further attempt on the simple kinetic modeling of a dense gas with phase changes.*

Abstract.
At the SAC/JSPS Seminar last year, we presented our attempt to construct a simple kinetic model of a dense gas with phase changes under the isothermal assumption. In the present talk, we will present our further attempts to develop the model. The primary issue is to remove the isothermal assumption and to reproduce the transport property, under the restriction of the H theorem.

J2: 10.00-10.30– Associate Professor, Kenta ISHIMOTO (RIMS Kyoto University),

Title: *Collective dynamics of microswimmers: multi-scale modelling via regularised Stokeslet representations.*

Abstract.
Many microscopic unicellular organisms swim in a fluid by using their hair-like appendage. The fluid dynamics around these tiny active particles, called microswimmers, are well described by the Stokes equation, and by the long-range nature of the hydrodynamic interactions, microswimmers often emerge collective behaviours when they get together. Nonetheless, due to the complexity of the flow around the individuals, numerical simulations for such collective dynamics typically oversimplify its hydrodynamics. In this talk, we introduce a data-driven modelling approach based on regularised Stokeslet representation of a swimmer and discuss some collective dynamics of hydrodynamically-interacting microswimmers.

10.30-10.40– Paus

Session 2, 10.40–12.10, (Chair: Professor Shigeru Takata)

J3: 10.40-11.10– Associate Professor Masahiro SUZUKI (Nagoya Inst of Tech)

Title: *The Kinetic and Hydrodynamic Bohm Criterions for Plasma Sheath Formation*

Abstract.
The purpose of this talk is to mathematically investigate the formation of a plasma sheath, and to analyze the Bohm criterions which are required for the formation. Bohm derived originally the (hydrodynamic) Bohm criterion from the Euler-Poisson system. Boyd and Thompson proposed the (kinetic) Bohm criterion from a kinetic point of view, and then Riemann derived it from the Vlasov-Poisson system. We study the solvability of boundary value problems of the Vlasov-Poisson system. On the process, we see that the kinetic Bohm criterion is a necessary condition for the solvability. The argument gives a simpler derivation of the criterion. Furthermore, the hydrodynamic criterion can be derived from the kinetic criterion. It is of great interest to find the relation between the solutions of the Vlasov-Poisson and Euler-Poisson systems. To clarify the relation, we also investigate the delta mass limit of solutions of the Vlasov-Poisson system. This talk is based on a joint work with Professor M. Takayama (Keio Univ.).

J4: 11.10-11.40– Professor Satoshi TAGUCHI, Graduate School of Informatics (Kyoto University)

Title: *Magnus effect in rarefied gas*

Abstract.
When moving in a fluid, a rotating sphere or cylinder experiences a transverse force. This effect, known as the Magnus effect, has a long history in fluid mechanics. In this talk, we consider a transverse force exerted on a rotating sphere immersed in a uniform stream of a rarefied gas. This situation arises, for example, when a suspended particle is very tiny and its size is comparable with the molecular mean free path of the gas. Under the condition that both Mach number and Reynolds number are small, we show that the transverse force acting on a sphere reverses its direction when the Knudsen number (i.e., the reciprocal ratio of the sphere radius to the mean free path) exceeds a certain threshold. The result clarifies the transition of the transverse force from the continuum to the free molecular limit, for which the transverse force is formerly known to have different signs.

C1: 11.40-12:10–PhD student Leon Frischauf (University of Wien)

Title: *Truncated SVD for applications in microwave thermometry*

Abstract.
Microwave hyperthermia is a technique used to improve the therapeutic results of traditional cancer therapies. It consists in increasing the tumor temperatures to levels of 40–44C while keeping the surrounding healthy tissue at normal temperatures. It is hence fundamental to have a real-time temperature monitoring in order to adjust the focal point in the target.

Mathematically the problem consists in solution of electromagnetic volume integral equation. In order to solve it we construct a Tikhonov's regularization functional and find optimal point of it. In the talk we will discuss different techniques to solve the optimization problem. Particularly, we will show how truncated SVD can be used for it's solution. Our numerical tests show performance of truncated SVD for 3D reconstruction of target during the process of microwave thermometry.

12.10-12.30– Paus

Session 3, 12.30–13.15, (Chair: Professor Imre Pazsit)

J5: 12.30-13.15 Professor Tomoko M. NAKANISHI, Plenary speaker (The University of Tokyo, Hoshi University)

Title: *Visualization of 14C-labeled Gas Fixation in a Plant*

Abstract.
We developed a real-time radioisotope (RI) imaging system for macroscopic and microscopic imaging, utilizing the available RIs for plants. The principle of visualization method was, after supplying radioisotopes to the plant, that the radiation emitted from the plant was converted to light by a Cs(Tl)I scintillator deposited on a fiber optic plate (FOS). Then the light was detected by a highly sensitive CCD camera to produce the successive image of the RIs moving in the plant. Many nuclides were employed, including 14C, 18F, 22Na, 28Mg, 32P 33P, 35S, 42K, 45Ca, 48V, 54Mn, 55Fe, 59Fe, 65Zn, 86Rb, 109Cd, and 137Cs. Since radiation can penetrate the soil as well as water, the difference between soil culture and water culture was visualized, which could demonstrate the difference in 137Cs absorption by the rice plant in Fukushima. Among the elements we targeted, we found that 14C, whose β-ray energy is low, could be imaged, applying 14C-labeled sucrose, in Arabidopsis. Therefore, we supplied carbon dioxide gas to visualize the carbon fixation process in the plant, as well as the movement of the assimilated carbon in the plant. The plants are always assimilating the invisible carbon dioxide gas to produce visible tissues. That is, most of the carbons consisting the plant is originated from carbon dioxide gas in the air. After applying the carbon dioxide to the plant, the interesting result we found was that the route of assimilated carbon was different depending on where the fixation took place. In Arabidopsis, most of the metabolites after photosynthesis were transferred to the tip of the main internode and roots when 14CO2 gas was fixed and photosynthates were produced at rosette leaves, whereas most of the metabolites moved to the tip of the branch internode and hardly moved down to the roots when 14CO2 gas was supplied to the aboveground parts of the plant other than rosette leaves. To image 14CO2 gas fixation in larger samples, approximately 50 cm in height, a plastic scintillator was introduced, and the assimilation process of the gas was visualized for rice and maize. Here, we present the real-time 14CO2 gas assimilation process of the plant with introduction of the imaging system we develped.

Session 4, 13.15–14.15, (Chair: Professor David Cohen)

C2: 13.15-13:45–Associate Professor Philip GERLEE (Chalmers)

Title: *Weak selection and time scale separation in ecological and evolutionary dynamics*

Abstract.
We show that under the assumption of weak frequency-dependent selection a wide class of population dynamical models can be analysed using perturbation theory. The inner solution corresponds to the ecological dynamics, where to zeroth order, the genotype frequencies remain constant. The outer solution provides the evolutionary dynamics and corresponds, to zeroth order, to a generalisation of the replicator equation. We apply this method to a model of public goods dynamics and construct, using matched asymptotic expansions, a composite solution valid for all times. We also analyse a Lotka-Volterra model of predator competition and show that to zeroth order the fraction of wild-type predators follows a replicator equation with a constant selection coefficient given by the predator death rate. For both models we investigate how the error between approximate solutions and the solution to the full model depend on the order of the approximation, and show using numerical comparison, for $k = 1$ and 2, that the error scales according to ε^{k+1}, where ε is the strength of selection and k is the order of the approximation.

C3: 13:45-14:15– Professor Larisa BEILINA (Chalmers)

Title: *A domain decomposition finite element/finite difference method for permittivity reconstruction from time-dependent scattered data in conductive media*

Abstract.
A new domain decomposition method for Maxwell's equations in conductive media will be presented. Using this method reconstruction algorithms are developed for determination of dielectric permittivity function using time-dependent scattered data of electric field. All reconstruction algorithms are based on optimization approach to find stationary point of the Lagrangian. Adaptive reconstruction algorithms and space-mesh refinement indicators will be also presented. Our computational tests show qualitative reconstruction of dielectric permittivity function using anatomically realistic breast phantom taken from online repository of University of Wisconsin UWCEM.

MARCH 18, 9:00-12:35 (Sweden)/17:00-20:35 (Japan)

Session 5, 9.00–10.45, (Chair: Professor Adrian Muntean)

C4: 9:00.-9.45–Professor Imre Pazsit, Plenary speaker (Chalmers)

Title: *The history and significance of the Klein-Nishina formula*

Abstract.
The late Professor Yoshio Nishina is considered as the founder of modern physics, and even that of the modern science in Japan. He was a universal scientist, doing research in both theoretical and experimental physics, and had seminal contributions in many areas. However, internationally, he is mostly known for the Klein-Nishina formula, which was the first application of the then new Dirac theory of the electron for scattering of light. He elaborated this formula together with the Swedish physicist Oscar Klein in 1928 when they both visited Niels Bohr's institute

in Copenhagen. This presentation gives a background of their work, starting with the state of science in Japan and the new quantum physics in Europe, as well as how the collaboration between Klein and Nishina arose, how the work was performed, and its meaning and significance in physics. Some other related historical facts and curiosities related to the work and achievements of Yoshio Nishina are also included. The material for this contribution arose mostly from the collaboration of the author with Prof. Kojiro Nishina, the second son of Yoshio Nishina, as well as from visits to Y. Nishina's birthplace and material from the Nishina Memorial Foundation.

J6: 9.45-10.15– Associate Professor Shugo YASUDA (Univ of Hyogo)

Title: *Chemotacitc aggregation of run-and-tumble bacteria*

Abstract.
We numerically investigate the aggregation of chemotactic bacteria based on a system of kinetic transport equations with internal states considering both running and tumbling pahses. It is found the bimodal aggregation occurs when the adaptation time and tumbling time are sufficiently large. An extended Keller-Segel model to describe the bimodal aggregation is also derived by a formal asymptotic analysis at the large adaptation-time scaling.

J7: 10.15-10.45– Associate Professor Kosuke SUZUKI (Shinshu University)

Title: *Some attempts to reproduce the pitching attitude control of butterflies through immersed boundary-lattice Boltzmann simulations*

Abstract.
Flapping flights of butterflies are generally unstable, and the attitude control for pitching rotation is essential to keep their flights. It has been considered that butterflies change the relative angle between the abdomen and thorax of their body to stabilize their thoracic pitching angles. In addition, as another possibility, it can be considered that their abdomen is passively swung by the thoracic motion which is controlled by other techniques (e.g., lead-lag motion of wings). In the present study, we attempt to clarify which scenario is more probable through CFD simulations using an immersed boundary-lattice Boltzmann method. In the simulations, we use a simple butterfly model composed of two rigid wings and a rod-shape body having the abdomen and thorax, and we consider two scenarios where the abdomen and thorax connected by a rotary actuator or a rotary spring.

10.45-11.00– Paus

Session 6, 11.00–12.30, (Chair: Professor Serik Segatov)

C5: 11.00-11.30– Professor Petter MOSTAD(Chalmers)

Title: *Medical age assessment for legal purposes: An application of Bayesian inference and optimal decision theory.*

Abstract.
To properly apply laws and rules to someone, their age may have to be determined. An example where this is challenging is the application of asylum law to asylum

seekers, where in many jurisdictions rules are less strict for children under the age of 18. When trusted documentation is lacking, legal decisions about age commonly involve various medical tests. As no biological or medical development follows chronological age perfectly, statistical methodology becomes important.

My talk reports our results from two of our papers: In the first, we assess the properties of a decision rule applied to more than 10.000 of the asylum seekers who arrived in Sweden during the surge of asylum seekers around 2015. Although the complete decision rule was never tested on persons with known chronological ages, we show how the use of a Bayesian stochastic model can elicit important properties of the decision procedure. Some of these properties directly contradict official claims.

In the second paper, we investigate the results of applying Bayesian decision theory to the medical age assessment problem. We show how general ethical decisions can be separated from considerations in individual cases. Using data for a medical assessment that involves both knee and tooth measurements, we show how its evidential value is still to weak to safely ignore often available prior information about age. We also discuss how incorporation of non-medical prior information can be done in practice.

C6: 11.30-12.00– Associate Professor Irina PETTERSSON (Chalmers)
Title: *Multiscale analysis of myelinated axons.*

Abstract.
A neuron is a basic structural unit of the nervous system, and one needs to know how a signal propagates along neurons to be able to simulate the excitation. We focus on the multiscale modeling of a myelinated axon. Considering a microstructure with alternating myelinated parts and nodes Ranvier, we derive an effective nonlinear cable equation describing the potential propagation along a single axon. Cable equations used in electrophysiology are traditionally formulated based on an equivalent circuit consisting of a capacitor in parallel with a conductor. Such models, however, do not take into account the geometry of the myelin sheath. I will also discuss some recent results about the multiscale analysis of a bundle consisting of many myelinated axons.

C7: 12.00-12.30– Professor Klas Modin (Chalmers)

Title: Zeitlin's model for 2D hydrodynamics

Abstract.
About 30 years ago, Vladimir Zeitlin suggested a finite mode truncation of Euler's equations on the 2-torus. It captures all the geometric features of 2D ideal hydrodynamics, including Arnold's geodesic interpretation. I'm interested in Zeitlin's model on the 2-sphere. The basic question is: how faithfully does the model capture the dynamics of Euler's equations? Can it yield new insights?

Final remarks & Closing

12.30-12.35–Professor Mohammad Asadzadeh. We plan a Springer proceedings for our JSPS/SAC workshops of mars 25-26, 2021, and mars 17-18, 2022. All speakers are invited to prepare articlers to sumbit. Contributions will go through usual referee procedure.