Title: Microlocal approximations of the Dirichlet-Neumann map for high-frequency scattering and related numerical methods

Speaker: Prof. Xavier ANTOINE
Institut Elie Cartan de Nancy & INRIA, Nancy-Université

Abstract: An overview of recent developments related to the construction of approximations of the Dirichlet-Neumann operator for high-frequency acoustic scattering will be given in a first part. These approximations play a key role for developing reliable and accurate numerical methods based for example on integral equations or variational volume formulations. Therefore, a second part of the talk will be devoted to some of these applications developed through collaborations with colleagues. We will emphasize on the interest of building new approximations and will propose some open questions.

Title: Emerging applications of spectral methods in quantum and plasma physics

Speaker: Prof. Weizhu Bao
Department of Mathematics and Center for Computational Science & Engineering, National University of Singapore

Abstract: In this talk, I will review different numerical approximations for the nonlinear Schrödinger equation (NLS) in the semiclassical regimes, where the scaled Planck constant is small. I also compare properties preserved in the discretized level of different numerical methods including time reversibility, time transverse invariant, mass conservation, energy conservation, stability, accuracy and resolution in the semiclassical regime. Finally, I show applications of spectral method to different problems in quantum and plasma physics including Zakharov system, Maxwell-Dirac equations and Klein-Gordon Schrödinger equations, etc.

Title: Magnetization reversal by spin transport

Speaker: Prof. Naoufel BEN ABDALLAH
Institute of Mathematics, Toulouse University and CNRS

Abstract: The use of spin currents in ferromganetic materials is one of the important issues in spintronics, a branch of electronics using the control and modulation of the spin of electrons rather than their charges. The magnetization in ferromganetic materials filters the spin of electrons through a torque term in the drift diffusion equation which models their evolution. The back reaction of the spin on the magnetization is present through the opposite torque term in the Landau Lifshitz equation for the Magnetization dynamics. We shall present in this work, the numerical simulation of a coupled model introduced by Fert etal and which models the reversal dynamics of the magnetization of a thin ferromagnetic materila by the injection of a polarized spin current injected from a thick ferromagnetic material.

This is a work in collaboration with Elise Fouassier, Clment Jourdana and David Sanchez.

Title: Adaptive Cell-average Spectral Element Methods for transient Wigner Equations in quantum transport

Speaker: Prof. Wei Cai, UNC Charlotte
Tiao Lu, PKU, Sihong Shao, PKU

Abstract: In this talk, we will introduce a new numerical method for solving time dependent Wigner equations with application to quantum transport. This method takes advantage of equivalent representations for the Wigner distribution function in the k-space between cell-averages (local electron density) and point values in the Chebyshev polynomial spaces. Coupled with conventional collocation method in the x-space, the resulting conservative algorithm provides a highly accurate method for the Wigner equations, and adaptivity in both x and k spaces are achieved within the spectral element framework to address the high dimensional Wigner distributions. Numerical results of quantum transport in resonant tunneling diode are included.

Title: Bloch decomposition based method for high frequency waves in periodic media

Speaker: Dr. Zhongyi Huang
Department of Mathematical Sciences, Tsinghua University

Abstract: In this talk, we introduce the Bloch-decomposition based time-splitting spectral method to conduct numerical simulations of the dynamics of (non)linear Schrödinger equations subject to periodic and confining potentials. We consider this system as a two-scale asymptotic problem with different scalings of the nonlinearity. In particular we discuss (nonlinear) mass transfer between different Bloch bands and also present three-dimensional simulations for lattice Bose-Einstein condensates in the superfluid regime.

This is a work in collaboration with Prof. Shi Jin, Peter A. Markowich and Christof Sparber.

Title: On the simulation of very high frequency electronic circuits

Speaker: Prof. Arieh Iserles
Department of Applied Mathematics and Theoretical Physics,
University of Cambridge

Abstract: The modelling of analogue or digital modulation in electronic circuits leads to very highly oscillatory ODEs, often with more than one frequency. Solving these equations with traditional methods requires time-stepping at the lowest wavelength level: this is prohibitively expensive and leads to an unacceptable error accumulation. In this work, joint with Marissa Condon and Alfredo Deaño, we use modern techniques of highly oscillatory quadrature to devise mixed numerical/asymptotic approach that provides very precise solution in a rapid and affordable manner.

Title: Multidimentional tunneling by quantum transition state theory

Speaker: Dr. Jing Shi
Wayne State University

Abstract:

Title: Numerical simulations on ground states of rotating Bose-Einstein condensate

Speaker: Dr. Hanquan Wang
School of Statistics and Mathematics, Yunnan University of Finance and Economics

Abstract: Recently, rotating Bose-Einstein condensate has been realized in experiments. Physicist are most interested in investigating its ground states at extremely low temperature. In this talk, we first study ground states in rotating one-component Bose-Einstein condensate (BEC) analytically and numerically. We start from the three-dimensional (3D) Gross-Pitaevskii equation (GPE) with an angular momentum rotation term, scale it to obtain a four-parameter model and reduce it to a 2D GPE in the limiting regime of strong anisotropic confinement. We discuss the existence/nonexistence problem for ground states (depending on the angular velocity). We perform numerical experiments computing ground states using a continuous normalized gradient flow method with a backward Euler finite difference discretization. Ground states are reported in both 2D and 3D for the rotating one-component BEC. Through our numerical study, we find various configurations with several vortices in the rotating one-component BEC. We next extend our study to the ground states of rotating two-component Bose-Einstein condensates. Finally we discuss our recent work on the ground states of rotating spin-1 Bose-Einstein condensates and that possible work can be done for the ground states of rotating spin-2 Bose-Einstein condensates.

Title: Computing Schrödinger equation using efficient Eulerian Gaussian beam method

Speaker: Dr. Hao Wu
Department of Mathematical Sciences, Tsinghua University

Abstract: The Gaussian beam method is an efficient way to solve the high frequency wave equations asymptotically with solution still being valid at caustics. In this talk, I will introduce a new Eulerian Gaussian beam method for solving Schrödinger equation in the semiclassical regime. The Lagrangian Gaussian beam formulation is also presented for the purpose of making the idea of Eulerian Gaussian beam clear. Finally, the idea can be easily extended to the related topics in Quantum Mechanics.

This is a joint work with Prof. Shi Jin(University of Wisconsin-Madison, USA) and Dr. Xu Yang(University of Wisconsin-Madison, USA).