4th SIAM Student Chapter@NUS Symposium on Applied and Computational Math

- **Date and location:** May 29th, 2015; S17-04-06 (Seminar Room 1), Department of Mathematics, Faculty of Science, National University of Singapore.

- **Sponsor:** Society of Industrial and Applied Mathematics (SIAM), National University of Singapore (NUS).

- **Committee:** Bao Weizhu (advisor); Wang Yan (president); Cui Ying (vice president); Zhao Yufei (secretary).

- **Description:** A one-day symposium on industrial and applied mathematics, including 2 plenary talks given by Prof. Adam Shaffique (from Department of Physics) and Prof. Jie Liu (from Department of Mathematics) and 7 talks given by research fellows in related areas. A free buffet pizza lunch and dinner[1] will be provided.

All are welcome!

SIAM
Society for Industrial and Applied Mathematics

NUS
National University of Singapore

[1] Dinner is free for speakers, committees and registered audience only.

Programme

Venue: S17-04-06 (Seminar Room 1)

08:50 - 09:00	**Opening remarks**
09:00 - 09:45	**Plenary talk by Prof. Adam Shaffique**
09:45 - 10:30	**Plenary talk by Prof. Jie Liu**
10:30 - 11:00	**Tea break & Group photo**
11:00 - 11:30	**Talk 3 by Xiaofei Zhao**
11:30 - 12:00	**Talk 4 by Xudong Li**
12:00 - 14:00	**Lunch**
14:00 - 14:30	**Talk 5 by Yuhui Quan**
14:30 - 15:00	**Talk 6 by Jing Xu**
15:00 - 15:30	**Talk 7 by Zhen Zhang**
15:30 - 16:00	**Tea break**
16:00 - 16:30	**Talk 8 by Shenglong Hu**
16:30 - 17:00	**Talk 9 by Xiaowei Jia**
From 17:30	**Dinner**

Title and abstract

- **Plenary talk 1: 09:00 - 09:45**
  - Speaker: Prof. Adam Shaffique
  - Title: TBA
  - Abstract: TBA
- **Plenary talk 2: 09:45 - 10:30**
  - Speaker: Prof. Jie Liu
  - Title: A second-order changing-connectivity arbitrary Lagrangian Eulerian scheme and its application to fluid-structure interaction with large convection of fluid and near-contact of structures.
  - Abstract: We propose a second-order characteristic-inclined changing-connectivity arbitrary Lagrangian Eulerian (ALE) scheme. It does not explicitly calculate the characteristics but allows characteristic-inclined discretization. Large mesh distortions are prevented by mesh smoothing and edge/face swapping techniques. The resulting semi-implicit scheme can therefore handle problems with large deformation of the domain and strong convection of the fluid. We use P_m/P_{m-1} ($m \geq 2$) or P_1-Bubble/P_1 ($m = 1$) finite elements and prove that the scheme converges at rate $O(\Delta t^2 + \frac{h^{m+2}}{\Delta t} + h^{m+1})$ in the incompressible Navier-Stokes equations (NSE) case. This gives optimal convergence rate when $h/\Delta t = O(1)$. To prove this result, we introduce a new interpolation operator which is easy to implement and enables us to keep the optimal convergence rate even if we change the connectively of the mesh in every time step. Numerical tests also confirm our theoretical results. We then apply our ALE scheme to solve fluid structure interaction (FSI) problems which may contain large convection of the fluid and near-contact of the structures. We prove the stability of the fully discrete semi-implicit second order FSI scheme. We then numerically confirm the order of convergence using a recently proposed 2D manufactured solution for FSI. In this example, part of the fluid domain can become arbitrarily narrow before going back to normal. Numerical tests for flow around rotating rigid and elastic crosses and flow induced opening and near-closing of a heart valve are performed.
- **Talk 3: 11:00 - 11:30**
  - Speaker: Dr. Xiaofei Zhao
  - Title: On multichannel solutions of nonlinear Schrdinger equations: algorithm, analysis and numerical explorations
  - Abstract: We apply the method of modulation equations to numerically solve the nonlinear Schrdinger with multichannel dynamics, given by a trapped localized state and radiation. This approach employs the modulation theory of Soffer Weinstein, which gives a system of ODEs coupled to the radiation term, which is valid for all times. We comment on the differences of this method from the well-known method of collective coordinates.
- **Talk 4: 11:30 - 12:00**

- Speaker: Dr. Xudong Li
- Title: Solving linearly constrained convex optimization problems with coupled objective functions
- Abstract: In this talk, we present an augmented Lagrangian framework for solving large scale linearly constrained convex optimization problems with coupled objective functions. In order to achieve a fast convergence rate of the augmented Lagrangian method, we introduce an inexact accelerated block coordinate descent algorithm to deal with the inner subproblems. Numerical results show that our proposed algorithm is efficient and robust.

- **Talk 5: 14:00 - 14:30**
  - Speaker: Dr. Yuhui Quan
  - Title: Data-Driven Multi-scale Non-local Wavelet Frame Construction and Image Recovery
  - Abstract: By assuming that images of interest can be sparsely modelled by some transform, the sparsity-based regularization has been one promising approach for solving many ill-posed inverse problems in image recovery. One often-used type of systems for sparsifying images is wavelet tight frames, which can efficiently exploit the sparse nature of local intensity variations of images. However, existing wavelet frame systems lack the capability of exploiting another important image prior, i.e., the self-recursion of local image structures in both spatial and scale domain. Such a self-recursion prior of image structures has led to many powerful non-local image restoration schemes with impressive performance. This talk is about developing a scheme for constructing a non-local wavelet frame or wavelet tight frame that is adaptive to the input image. The proposed multi-scale non-local wavelet frame allows the resulting regularization simultaneously exploits both the sparse prior of local variations of image intensity and the global self-recursive prior of image structures in spatial domain and across scales. Based on the proposed construction scheme, a powerful regularization method is developed for solving image deconvolution problem. The experiments showed that the results from the proposed regularization method are compared favorably against that from several popular image restoration methods.

- **Talk 6: 14:30 - 15:00**
  - Speaker: Dr. Jing Xu
  - Title: Disposition Effect Puzzle: Behavior, Psychology and Finance Theories
  - Abstract: Disposition effect, i.e., investors tend to realizes gains more often than losses, has been widely documented in the empirical finance literature. Behavioral types of explanations, which usually involve psychological sciences, have dominated the literature. However, whether these psychological reasons can really explain the disposition effect is still very controversial. In this talk, I will briefly review the existing investigations, and provide a novel rational explanation of the disposition effect.

- **Talk 7: 15:00 - 15:30**
  - Speaker: Zhen Zhang

- Title: Modeling and simulation of moving contact line problem for two-phase complex fluids flow
- Abstract: We introduce the sharp interface models for moving contact lines with insoluble surfactants and polymeric fluids. A continuous model is derived for the dynamics of two immiscible fluids with moving contact lines and insoluble surfactants based on thermodynamic principles. The interface condition, the boundary condition for the slip velocity, and the condition for the dynamic contact angle are derived from the consideration of energy dissipations. A finite element numerical method is developed to solve the coupled partial differential equation. We also discuss the model reduction of the slip model to the no-slip limit by the technique of asymptotic analysis.

- **Talk 8: 16:00 - 16:30**
  - Speaker: Dr. Shenglong Hu
  - Title: Tensors and hypermatrices: decompositions and eigenvectors
  - Abstract: In this talk, basic notions of tensors (hypermatrices) will be presented, such as rank, generic rank, symmetric rank, hyperdeterminant, (symmetric) decomposition, Sylvester's algorithm, apolarity, etc. We will in particular show how eigenvectors of tensors can be used to reconstruct a generic fifth order three dimensional symmetric tensor (or a generic plane quintic).

- **Talk 9: 16:30 - 17:00**
  - Speaker: Mr. Xiaowei Jia
  - Title: Multi-scale Analysis for the Dirac Equation in Nonrelativistic Limit Regime
  - Abstract: We propose and analysis a multiscale decomposition wave integrator Fourier pseudospectral method(MD-EWI-FP) for the Dirac equation with a dimensionless parameter $0 < \varepsilon \leq 1$. In the nonrelativistic limit regime, i.e. $0 < \varepsilon \ll 1$ the Dirac equation obtains a solution which is highly oscillatory in time. The solution porpogates waves with amplititude $O(\frac{1}{\varepsilon^2})$ in time which would bring a lot of computational burdan in the conventional numerical methods such as finite difference or time-splitting methods. We combine the mutiscale decomposition and wave integrator Fourier pseudospectral method to design a uniform MD-EWI-FP method for the nonrelativistic limit regime. The time step could be chosen independent of ε and the error estimate is $O(h^m + \tau)$. The numerical examples and comparisons are reported to confirm the accuracy and efficiency of the MD-EWI-FP at last.