Abstract for HKUST IAS-HKWM-EASIAM Joint Workshop on Recent Advances on Scientific Computing, Random Matrices and Data Science (December 18-20, 2024)

Modeling, Stability Analysis and Numerical Computation for Complex Fluid Problems Arising from Industrial Applications

Dongdong He

School of Science and Engineering, The Chinese University of Hong Kong, Shenzhen, P. R. China

Email: hedongdong@cuhk.edu.cn

In this talk, I will present some recent work on stability analysis and numerical methods for complex non-Newtonian fluid problems. Firstly, I will present results for the linear and nonlinear stability analysis a surfactant-laden viscoelastic Oldroyd-B /FENE-P thread [1]. For nonlinear dynamics studies, a set of longwave equations are obtained by using slender body approximation. These longwave equations are solved by using finite difference methods. Results show surfactant can affect the dynamics of the threads greatly, surface viscoelasticity of the surfactant can eliminate the satellite droplets, which has great potential in industrial applications. Secondly, I will discuss the structure preserving numerical methods for solving electro-hydrodynamic viscoelastic Oldroyd-B flow model in reference [2], energy stable structure preserving numerical methods are developed, the positive-definiteness preserving for the conformation tensor is achieved by using the logarithm transformation. Numerical examples confirm the properties of the proposed schemes. And viscoelastic flow with Weissenberg number up to 20 are computed, results show that elasticity destabilizes the flow structure and strongly influences the charge transport. Finally, if time allows, I will also present some recent work on developing structure preserving methods for Navier-Stokes-Poisson-Nernst-Planck system [3].

References:

1. Fang Li, Dongdong He*, Dynamics of a surfactant-laden viscoelastic thread in presence of surface viscosity. Journal of Fluid Mechanics. 966 (2023) A35.
2. Mingyang Pan, Qinghe Wang, Dongdong He*, Kejia Pan, Positive-definiteness preserving and energy stable semi-Lagrangian method for a diffusive Oldroyd-B EHD model. Communications in Nonlinear Science and Numerical Simulation. 96 (2021) 105630.
3. Mingyang Pan, Sifu Liu, Wenxing Zhu, Fengyu Jiao, Dongdong He*, A linear second order positivity-preserving and unconditionally energy stable scheme for the Navier-Stokes-Poisson-Nernst-Planck system. Communications in Nonlinear Science and Numerical Simulations. 131 (2024) 107873.