

SPECTRAL METHODS FOR COLLISIONAL KINETIC EQUATIONS

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ABSTRACT

From classical rarefied gas dynamics to modern socio-economic and biological modeling, understanding non-equilibrium behavior relies heavily on capturing microscopic interactions of particles. Collisional kinetic equations represent the most appropriate models to describe such multiscale phenomena. However, because the overarching evolution of these systems is governed by complex collision integrals, accurately simulating these dynamics is extremely challenging. Thus, an accurate and fast treatment of these interactions is necessary for robust results.

Several numerical methods have been developed to provide reliable approximations of collisional equations and deterministic methods have consistently shown strong robustness and stability. In this framework, spectral methods have emerged as a powerful tool. By exploiting Fourier representations, convolution-type formulations, and fast summation algorithms, spectral techniques enable the efficient evaluation of the collision operator while retaining high-order accuracy for smooth profiles and allowing the preservation of the main physical invariants.

This minisymposium aims to present recent advances in various aspects of spectral methods for collisional kinetic equations, focusing on numerical properties and computational aspects, including the embedding of these methods in large-scale computations of rarefied gases and plasmas. We bring together researchers from different communities of the field, with the scope of encouraging discussions and providing insights for possible future collaborations.

SPEAKERS

1. Giacomo Borghi (Heriot-Watt University, Edinburgh, United Kingdom): Spectral particle methods for the Landau equation.
2. Walter Boscheri (Université Savoie Mont Blanc, Chambéry, France): High order schemes for the Boltzmann model on unstructured meshes.
3. Jingwei Hu (University of Washington, Washington, United States of America): Fast Fourier Spectral Methods for Kinetic Simulation of Burning Fusion Plasmas.
4. Tino Laidin (Université de Bretagne Occidentale, Brest, France): Conservative spectral methods.
5. Jaeyong Lee (Chung-Ang University, Seoul, South Korea): Deep Learning Approaches for Solving Kinetic Equations
6. Yanli Wang (Beijing Computational Science Research Center, Beijing, China): Hermite spectral method for the Boltzmann equation.