

## COMPUTATIONAL KINETIC THEORY

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### ABSTRACT

Kinetic models have emerged as a comprehensive and versatile multiscale modeling paradigm in many applications in science and engineering to simulate transport in and out of equilibrium, e.g. rarefied-gas dynamics, radiative transfer, plasma physics, dispersed-particle flows, galactic dynamics, etc. Kinetic theories typically lead to high-dimensional equations, in which interactions manifest themselves as complicated non-linear integro-differential operators. The high dimensional setting of kinetic problems implies that the corresponding computational complexity is prohibitive, particularly when attempting to simultaneously resolve both equilibrium and nonequilibrium flow phenomena.

Recent advances in the numerical approximations for kinetic theories exploit fundamental structural properties of kinetic equations related to trends toward equilibrium and corresponding hydrodynamic (continuum) limits. Exploiting such properties enables the derivation of efficient and robust methods that are capable of adaptive resolution of equilibrium and non-equilibrium effects. However, computationally scaling such methods to complex geometries remains an outstanding challenge.

The aim of this mini-symposium is to assemble researchers in the area of multiscale modeling, analysis and simulation of kinetic theories, in order to discuss recent developments, to explore open issues, and to foster cross-fertilization. The envisaged range of topics spans (but is not limited to):

- Moment theories for kinetic equations
- Hydrodynamics and continuum limits

- Scale-bridging and adaptive methods
- Structure-preserving discretization techniques

## REFERENCES

- [1] Sone, Yoshio, ed. Molecular gas dynamics: theory, techniques, and applications. Boston, MA: Birkhäuser Boston, 2007.
- [2] Cercignani, Carlo, and Carlo Cercignani. The boltzmann equation. Springer New York, 1988.