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ADVANCED STRUCTURE-PRESERVING MOMENT METHODS AND NUMERICS OF KINETIC EQUATIONS

TRACK NUMBER: 1600 (MULTISCALE AND MULTIPHYSICS SYSTEMS)

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ABSTRACT

Kinetic equations bridge microscopic particle dynamics and macroscopic hydrodynamic theories. They arise in a wide range of natural phenomena and engineering processes, such as rarefied gases, plasmas, particulate flows, and collective behaviors of active/living matter. Despite the solid physical foundation, the high dimensionality of kinetic equations makes them computationally prohibitive for most practical applications.

Moment methods provide an effective model reduction framework, offering physical interpretability and computational tractability while preserving key physical properties such as conservation laws. Recent years have witnessed rapid advances in both theory and computation of moment systems [1]. Novel closure strategies have emerged, ranging from classical Grad-type and quadrature-based approaches to entropy-based formulations, macro-micro decompositions, and data-driven or hybrid closures. Parallel developments in mathematical analysis of realizability, hyperbolicity, dissipativeness and well-posedness have provided a stronger theoretical basis for these methods [2]. Furthermore, advanced numerical techniques are expanding the applicability of moment systems in practice.

This Minisymposium aims to bring together researchers working on applied mathematics, computational science, and engineering to present the latest progress, exchange ideas, and enlighten future research directions of moment methods and numerics for kinetic equations. Contributions are particularly encouraged in:

(1) Moment closure strategies, either mechanistic or data-driven, with solid mathematical foundations and computational efficiency.

(2) Advanced numerical methods, including (but not limited to) high-order, asymptotic- and/or bound-preserving schemes, and methods for non-conservative moment systems.

(3) Applications of moment methods to problems in applied sciences and engineering.

REFERENCES

[1] T. Pichard, *Some recent advances on the method of moments in kinetic theory*, ESAIM: Proceedings and Surveys 75 (2023) 86-95.

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