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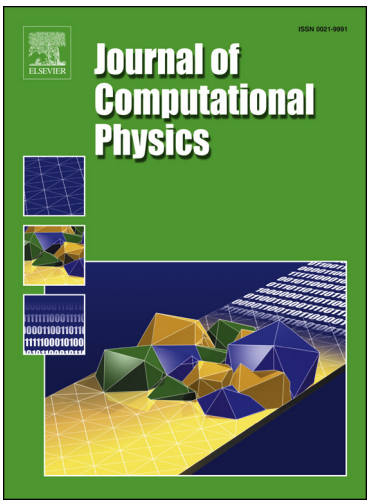

An efficient numerical method for solving the Boltzmann equation in multidimensions

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An efficient numerical method for solving the Boltzmann equation in multidimensions

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Abstract

In this paper we deal with the extension of the Fast Kinetic Scheme (FKS) [J. Comput. Phys., Vol. 255, 2013, pp 680-698] originally constructed for solving the BGK equation, to the more challenging case of the Boltzmann equation. The scheme combines a robust and fast method for treating the transport part based on an innovative Lagrangian technique supplemented with conservative fast spectral schemes to treat the collisional operator by means of an operator splitting approach. This approach along with several implementation features related to the parallelization of the algorithm permits to construct an efficient simulation tool which is numerically tested against exact and reference solutions on classical problems arising in rarefied gas dynamic. We present results up to the 3D×3D case for unsteady flows for the Variable Hard Sphere model which may serve as benchmark for future comparisons between different numerical methods for solving the multidimensional Boltzmann equation. For this reason, we also provide for each problem studied details on the computational cost and memory consumption as well as comparisons with the BGK model or the limit model of compressible Euler equations.

Keywords: `Boltzmann equation, kinetic equations, semi-Lagrangian schemes, spectral schemes, 3D/3D, GPU, CUDA, OpenMP, MPI.`
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Contents

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