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Frequency-Domain DSMC Method for Oscillatory Gas Flows

DANIEL LADIGES, JOHN SADER, The University of Melbourne — Gas flows generated by resonating nanoscale devices inherently occur in the non-continuum, low Mach number regime. Numerical simulation of such flows presents a tremendous challenge, which has motivated the development of several direct simulation Monte Carlo (DSMC) methods for low Mach number flows. We present a frequency-domain DSMC method for oscillatory low Mach number gas flows, based on the linearized Boltzmann equation. This circumvents the need for temporal simulations, providing direct access to both amplitude and phase information using a pseudo-steady algorithm. The proposed method is demonstrated with several examples, and good agreement is found with both existing time-domain DSMC methods and accurate numerical solutions of the Boltzmann-BGK equation. Analysis of these simulations, using a rigorous statistical approach, shows that this frequency-domain method provides a significant improvement in computational speed compared to existing time-domain DSMC methods.

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