

Supersonic flow kinetics: Mesoscale structures, thermodynamic nonequilibrium effects and entropy production mechanisms

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Supersonic flow is a typical nonlinear, nonequilibrium, multiscale, and complex phenomenon. Compared to scenarios described by Navier-Stokes (NS) theory, mesoscale behavior in supersonic flow exhibits greater discreteness and a higher degree of nonequilibrium. Meanwhile, the entropy production mechanism, which involves compression efficiency and the ability to perform external work, is a significant focus in supersonic flow fields. As the degree of discrete/nonequilibrium effects increases, the study of entropy production based on NS theory may need reevaluation and appropriate revision. To address these issues, this paper develops and applies the discrete Boltzmann *modeling and analysis* method/model (DBM), based on kinetic and mean-field theories, to simulate, and analyze these phenomena. The study provides the following results: A Burnett-level DBM suitable for supersonic flow is constructed based on the Shakhov-BGK model. Higher-order analytical expressions for typical thermodynamic nonequilibrium

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Nonequilibrium Effects In Supersonic Noz

Daniel F McAuley



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