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Numerical and Application Solution of 14-Moment Maximum-Entropy-Based Moment Closures for Describing High-Speed Non-Equilibrium Gaseous Flows

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The development and application of novel 14-moment maximum-entropy-based moment closures are explored for prediction of high-speed non-equilibrium gaseous flows with shocks. Closure formulations based on both an interpolative approach as well as that based on a bi-Gaussian approximation for the distribution function are considered. Both closure strategies possess or mimic many of the desirable mathematical and computational features of closures following maximum-entropy principles on which they are based. However, in contrast to closures based directly on maximum-entropy concepts, the proposed interpolative and bi-Gaussian closures afford closed-form expressions for the closing moment fluxes and thereby avoid costly numerical solution procedures commonly associated with the latter. A Godunov-type finite-volume scheme with block-based anisotropic adaptive mesh refinement (AMR) is also described for the efficient solution of the resulting moment equations on multi-block body-fitted hexahedral mesh and the suitability and accuracy of the 14-moment systems for describing non-equilibrium gaseous flows with shocks is demonstrated by considering several canonical flow problems, including planar shock structure.