

Abstract Submitted
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The second-order description of rotational non-equilibrium effects in polyatomic gases¹ RHO SHIN MYONG, Gyeongsang National University — The conventional description of gases is based on the physical laws of conservation (mass, momentum, and energy) in conjunction with the first-order constitutive laws, the two-century old so-called Navier-Stokes-Fourier (NSF) equation based on a critical assumption made by Stokes in 1845 that the bulk viscosity vanishes. While the Stokes' assumption is certainly legitimate in the case of dilute monatomic gases, ever increasing evidences, however, now indicate that such is not the case, in particular, in the case of polyatomic gases—like nitrogen and carbon dioxide—far-from local thermal equilibrium. It should be noted that, from room temperature acoustic attenuation data, the bulk viscosity for carbon dioxide is three orders of magnitude larger than its shear viscosity. In this study, this fundamental issue in compressible gas dynamics is revisited and the second-order constitutive laws are derived by starting from the Boltzmann-Curtiss kinetic equation. Then the topology of the second-order nonlinear coupled constitutive relations in phase space is investigated. Finally, the shock-vortex interaction problem where the strong interaction of two important thermal (translational and rotational) non-equilibrium phenomena occurs is considered in order to highlight the rotational non-equilibrium effects in polyatomic gases.

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