Extended thermodynamics with six fields for dense polyatomic gases

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Extended thermodynamics (ET) of monatomic gases [1] and of rarefied polyatomic gases [2,3] has been developed to describe the nonequilibrium phenomena beyond the assumption of local thermodynamic equilibrium. Their validity is confirmed by comparing the theoretical predictions to the experimental data of sound waves, shock waves and light scattering. In this talk, I present the ET theory of dense polyatomic gases, particularly, the theory with six fields where the shear viscosity and heat conductivity are neglected [4]. I propose the balance equations by postulating a simple principle of duality between rarefied and dense gases based on the microscopic analysis of the energy exchange between different modes of the molecular motion. The closed field equations are obtained by adopting the closure of ET which requires the Galilean invariance, entropy principle and thermodynamic stability. I also discuss the origin of the dynamic (nonequilibrium) pressure from the aspect of nonequilibrium temperature. In the theory, there emerge two nonequilibrium temperatures; one is due to the translational mode, and the other is due to the internal modes such as rotation and vibration of a molecule.

References

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