Nonlinear Extended Thermodynamics of Real Gases with Six Fields, Part II: Comparison with the Meixner Theory of Relaxation Processes

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As explained in the previous talk, Part I, we have established nonlinear extended thermodynamics of real gases with 6 independent fields (ET6), i.e., the mass density, the velocity, the temperature and the dynamic pressure (nonequilibrium pressure), without adopting the near-equilibrium approximation \cite{1}. We have proved its compatibility with the universal principles (the entropy principle, the Galilean invariance and the stability), and have obtained the symmetric hyperbolic system with respect to the main field. In the near-equilibrium case, the previous linear theory \cite{2, 3} is naturally recovered by the nonlinear ET6 theory.

In the present talk, Part II, we compare the ET6 theory with the Meixner theory of relaxation processes with one internal variable, and we discuss the physical implications involved \cite{1}. Through studying real gases composed of polyatomic molecules, we discuss the connection between the ET6 theory and the Meixner theory by comparing the two nonlinear systems of field equations with each other. We prove that the internal variable and the nonequilibrium temperature introduced in the Meixner theory can be expressed explicitly in terms of the macroscopic variables of the ET6 theory. We see that the dynamic pressure, in particular, plays an essential role. The affinity and the relaxation time in the Meixner theory are also evaluated by the macroscopic variables of ET6. Nonequilibrium temperatures defined in these theories are also compared and discussed.

Lastly some potential applications of the ET theory are discussed briefly.

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