Weakly nonlinear waves in non-ideal fluids

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Abstract

We study the propagation of weakly nonlinear waves in non-ideal fluids in which the local value of the fundamental derivative changes sign. Perturbation expansions with multiple scales are used to study the behavior of the flow governed by the usual Navier-Stokes equations with viscosity and thermal conduction, supplemented by the equation of state for a van der Waals fluid; the transport equation is a parabolic evolution equation that includes both quadratic and cubic nonlinearities inherent in the governing hyperbolic system. Riemann's solutions of the associated kinematic equation are presented with a rectangular pulse initial distribution. The interaction time of shocks and wave-fans, speeds and strengths of shocks, widths of wave-fans, and the eventual decay rate of merged shocks, influenced by the van der Waals parameters, are investigated. The parabolic evolution equation, in the hyperbolic limit, is solved numerically using the fifth order WENO scheme and the results are compared with the exact analytical solutions of the associated kinematic equation.

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