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MACH WAVE AND ACOUSTICAL WAVE STRUCTURE IN NONEQUILIBRIUM GAS-PARTICLE FLOWS

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Abstract: In this Element, the gas-particle flow problem is formulated with momentum and thermal slip that introduces two relaxation times. Starting from acoustical propagation in a medium in equilibrium, the relaxation-wave equation in airfoil coordinates is derived though a Galilean transformation for uniform flow. Steady planar small perturbation supersonic flow is studied in detail according to Whitham's higher-order waves. The signals owing to wall boundary conditions are damped along the frozen-Mach wave, and are both damped and diffusive along an effective-intermediate Mach wave and diffusive along the equilibrium Mach wave where the bulk of the disturbance propagates. The surface pressure coefficient is obtained exactly for small-disturbance theory, but it is considerably simplified for the small particle-to-gas mass loading approximation, equivalent to a simple-wave approximation. Other relaxation-wave problems are discussed. Martian dust-storm properties in terms of gas-particle flow parameters are estimated.

Keywords: Mach waves, gas-particle flow, wall pressure coefficient, analytical methods, acoustic waves

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