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Similarity solution for laser-driven shock waves in a dust-laden gas with internal heat transfer effects

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Abstract

The non-adiabatic flow behind a laser-driven strong shock wave propagating in a mixture of gas and small solid particles is the subject of this paper. A similarity solution which accounts for the influence of internal heat fluxes due to high temperatures achieved at the centre has been obtained. The heat fluxes in the blast-wave equations are considered in terms of Fourier's law for conduction and by an expression for thermal radiation of the diffusion type. As for adiabatic flow, it is assumed that the equilibrium-flow condition is maintained and that the variable laser energy is completely absorbed at the shock front according to a time-dependent power law. The formulation results in a two-point boundary-value problem. The effects of a parameter characterising the various energy input of the blast wave on the similarity solution as well as on its limits have been examined. The computations have been performed for various values of mass concentration of the solid particles and for the ratio of density of solid particles to the constant initial density of gas.

Keywords: Laser radiation; Variable-energy blasts; Dust-laden flow; Self-similar solution; Thermal radiation and convection

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