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Linear Stability Analysis of Self-Similar Ablation Flows of ICF

SERGE GAUTHIER, JEAN-MARIE CLARISSE, CARINE BOUDESOCQUE-DUBOIS, VIRGINIE LOMBARD, CEA/Bruyères-le-Châtel — The stability of an ablative flow is of crucial importance in inertial confinement fusion (ICF). In particular, laser imprinting on accelerated target determines the seeds for the acceleration phase Rayleigh-Taylor instability. We present the first analysis of the imprinting problem using a dynamic solution. We first exhibit a family of exact self-similar solutions of the gas dynamics equations with nonlinear heat conduction. Such self-similar solutions are representative of the early stage of the pellet ablation by a laser. A wide variety of ablation configurations may thus be obtained. Linear stability analyses of such time-dependent solutions are then performed by solving an initial and boundary value problem. These similar solutions and their 3D perturbations are computed using a highly accurate numerical method, namely an auto-adaptive multidomain Chebyshev spectral method.Various solutions may be studied, depending on the choice of initial conditions. Generally and by contrast with steady low Mach number models for ablation front, we obtain that: (a) maximum perturbation amplitudes in the thin ablation layer are reached for transverse wavenumber k=0; (b) the growth and damping of ablation front perturbations are clearly related to thermal diffusion; (c) ablation front perturbations seem to persist although the transverse wave number increases.

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