Multimode Classical Rayleigh-Taylor Experiments at Nova*

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The evolution of the Rayleigh-Taylor (RT) instability at an ablation front has been studied extensively due to its potential impact on inertial confinement fusion. Recent work showed strong growth of short wavelength modes ($\leq 10\ \mu$m) at an embedded, classical interface in marked contrast to observations at the ablation front. [1] This work has been extended to the study of multimode perturbations at an embedded interface to investigate the prediction of an *inverse cascade*, or trend toward progressively longer wavelength structures dominating the flow, as first predicted by Sharp and Wheeler. [2]

As the growth of the initial modes enters the nonlinear regime, ($k\eta > 0.1$), an initially sinusoidal perturbation assumes the characteristic "bubble and spike" shape and the initial modes begin to *couple* producing the beat modes $k_1 \pm k_2 = k_\pm$. Results will be presented for the growth of perturbations consisting of two, ten, and twenty modes with various amplitudes superposed in phase. The targets consisted of 40 μm of brominated plastic ($C_{50}H_{17}Br_3, \rho = 1.26$ g/cm^3) backed with a 15 μm titanium ablator ($\rho = 4.5$ g/cm^3) mounted across a hole on a 3 mm long by 1.6 mm diameter gold hohlraum. The perturbation is placed at the CH(Br)-Ti boundary, effectively isolated from the effects of ablation. Eight Nova beams at $\lambda = .351\ \mu$m are used to generate a 3.5 or 4.5 ns shaped, low-adiabat drive. The ablatively accelerated target is back-illuminated with 6.7 keV He $-\alpha$ x-rays generated by the remaining two Nova beams at $\lambda = .528\ \mu$m impinging on an iron foil. A gated x-ray imager (FXI) is utilized to record the images which are then converted to $\ln$(exposure) $\propto -$OD $= -\int \rho\kappa dz$, where ρ is density and κ is opacity, and analyzed by Fourier decomposition.

For several of the targets studied, the wavelengths of the initial modes were below the experimental resolution ($\sim 7\ \mu$m at $12\times$ magnification). The growth of these subresolution modes is diagnosed by observing the appearance of the coupled beat modes and then using 1D calculations to infer the growth of the initial modes.

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[1] K. S. Budil *et al.*, "Classical Rayleigh-Taylor Experiments at Nova", in press *Phys. Rev. Lett.* (1996).

[2] D. H. Sharp and J. A. Wheeler, "Late Stage of Rayleigh-Taylro Instability", Institute for Defense Analyses, unpublished report (1961); J. Glimm *et al.*, "A numerical study of bubble interactions in Rayleigh-Taylor instability for compressible fluids", *Phys. Fluids A* **2**, 2046 (1990).