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Nonlinear bubble competition of the multimode ablative Rayleigh-Taylor instability and applications to inertial confinement fusion

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The self-similar nonlinear evolution of the multimode ablative Rayleigh-Taylor instability (RTI) and the ablation-generated vorticity effect are studied for a range of initial conditions. It is shown that the nonlinear multimode bubble-front penetration follows the gt^2 scaling law with α_b dependent on the initial conditions and ablation velocity. The value of α_b is determined by the bubble competition theory, indicating that mass ablation reduces ab with respect to the classical value for the same initial perturbation amplitude. We also show that, unlike classical RTI, the nonlinear multimode bubble-front evolution persists in the bubble competition regime due to ablation-generated vorticity which accelerates the bubbles, thereby preventing a transition into the bubble-merger regime. We show that vorticity inside the multimode bubbles is most significant at small scales with large initial perturbation. Since these small scales is in the bubble competition regime, the self-similar growth coefficient α_b can be enhanced by up to 30% relative to the bubble competition model without vorticity effects. We use the ARTI bubble competition model to explain the hydrodynamic stability boundary observed in OMEGA low-adiabat implosion experiments.

References

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Figure xx

Note: Abstract should be in 1 page.