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Observation of Rayleigh–Taylor-instability growth in a plasma regime with magnetic and viscous stabilization[1]

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Rayleigh–Taylor-instability (RTI) growth during the interaction between a high-Mach-number, unmagnetized plasma jet [1] and a stagnated, magnetized plasma is observed in a regime where the growth of short-wavelength modes is influenced by plasma viscosity and magnetic fields [2]. The time evolution of mode growth at the mostly planar interface is captured by a multi-frame fast camera. Interferometry, spectroscopy, photodiode, and magnetic probe diagnostics are employed to experimentally infer n_i, T_e, $\bar{Z}$, acceleration, $\vec{B}$, and ion viscosity in the vicinity of the evolving interface. As the instability grows, an evolution from mode wavelengths of ≈ 1.7 cm to ≈ 2.8 cm is observed. The growth time (~ 10 μs) and wavelength (~ 1 cm) of the observed modes agree with theoretical predictions computed from the experimentally inferred density ($\sim 10^{14}$ cm^{-3}), deceleration ($\sim 10^9$ m/s^2), and magnetic field (≈ 15 G in direction of wavevector). Furthermore, comparisons of experimental data with idealized magnetohydrodynamic simulations (which include a physical viscosity model) suggest that both magnetic and viscous stabilization contribute to the observed mode evolution. These data are relevant for benchmarking astrophysical and magneto-inertial-fusion-relevant computations of RTI.

[1] S. C. Hsu et al., Phys. Plasmas **19**, 123514 (2012).
[2] C. S. Adams, A. L. Moser, and S. C. Hsu, submitted (2015); http://arxiv.org/abs/1412.6033.

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