

Abstract Submitted
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Rayleigh-Taylor Instability in Nonlinear Schrödinger Flow SHU JIA, JASON W. FLEISCHER, Princeton University — We consider the Rayleigh-Taylor instability in nonlinear Schrödinger flow. In this superfluid-like case, wave diffraction, rather than viscosity or surface tension, sets the spatial scale for long-wave growth. Theoretically, we apply a polar (Madelung) transformation to the complex wavefunction and map intensity to density and velocity to the gradient of the phase. We show analytically that, unlike the instability dynamics in normal fluids, the superfluid behavior is strongly nonlinear and compressible from the start. Experimentally, we demonstrate the instability all-optically in a photorefractive crystal, using a self-defocusing nonlinearity as an effective pressure and a refractive index gradient as the driving acceleration. Observations of the characteristic spatial period show excellent agreement with scaling calculations from perturbation theory. We find that density fingering is always accompanied by vortex generation and that pressure effects strongly influence the finger period and mixing depth. The results hold for any Schrödinger fluid, e.g. superfluids and quantum plasma, and lay the foundation for a variety of fluid-inspired instabilities in nonlinear optics.

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