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Rosenbluth Award: First observations of Rayleigh-Taylor-induced magnetic fields in laser-produced plasmas using x rays and protons

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Recent experiments [Manuel, PRL 108 (2012)] demonstrated the existence of self-generated B-fields from the Rayleigh-Taylor (RT) instability in laser-produced plasmas, as originally predicted by Mima et al. [Mima PRL 41 (1978)]. Misaligned density and temperature gradients caused by RT growth in ablatively driven targets generate B-fields in the plasma through the Biermann battery source. X-ray and proton radiography diagnosed areal-density and B-field perturbations in laser-irradiated targets with seeded sinusoidal surface perturbations. Inferred B-field strengths indicated ratios of thermal to magnetic pressures (β) near the ablation surface of 10^4–10^5, suggesting no magnetic effects on ablative RT during the linear growth phase. However, the magnitude of this self-generated field increases with the perturbation height [Srinivasan, PRL 108 (2012)] and can affect morphology in the nonlinear regime. The detailed structure of highly nonlinear RT spikes is important to understand the inner wall expansion of hohlraums in indirect-drive inertial fusion and in multiple astrophysical systems, including the explosion phase of core-collapse supernovae and formation of planetary nebulae. Numerical calculations investigating the magnetic effects on nonlinear RT-spike evolution under conditions similar to previous measurements will be covered and implications discussed.

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