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Wave-Wave and Wave-Particle Nonlinear Behavior Observed in Laser-Plasma Interaction Experiments D.S. MONTGOMERY, J.L. KLINE, B.J. ALBRIGHT, B. BEZZERIDES, E.S. DODD, D.F. DUBOIS, H.A. ROSE, M.J. SCHMITT, L. YIN, LANL, H.X. VU, UCSD — Controlling laser-plasma interactions is of critical importance to achieving fusion ignition at the National Ignition Facility. The high laser intensities encountered in these plasmas are typically sufficient to exceed the threshold for parametric instabilities, such as stimulated Raman scattering (SRS), where an intense laser wave decays into a Langmuir wave (LW) and a scattered light wave. The saturation of SRS occurs as the LW dissipates energy into other waves (wave-wave coupling) or into the electrons (wave-particle coupling). While such phenomena are readily observed in fully kinetic simulations, the ability to detect the subtle signatures of wave-wave and wave-particle nonlinear behavior in experiments is masked by the plasma inhomogeneity found in these small scale ($\sim$ 1 mm) plasmas. To overcome this, an experimental test-bed was developed using a diffraction-limited laser beam to interact with a preformed plasma and drive SRS in well-characterized and homogeneous conditions. This novel technique has enabled the observation of Langmuir Decay Instability cascade, the nonlinear frequency shifts due to electron trapping, as well as the observation of scattering from a trapped electron-acoustic mode. These results validate our fundamental understanding of these processes, and help guide the development of predictive capabilities in this field.

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