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Distinguishing mechanisms of plasma-based amplification for short laser pulses QING JIA, Department of Astrophysical Sciences, Princeton University, MATTHEW EDWARDS, Department of Mechanical and Aerospace Engineering, Princeton University, IDO BARTH, Princeton Plasma Physics Laboratory, JULIA MIKHAILOVA, Department of Mechanical and Aerospace Engineering, Princeton University, NATHANIEL FISCH, Department of Astrophysical Sciences, Princeton University — Several plasma-based amplification mechanisms have been proposed to obtain short laser pulses with ultrahigh intensities beyond the damage threshold of solid-state devices, including Compton-like superradiant amplification, backward Raman amplification and strongly-coupled Brillouin amplification. These three mechanisms are all based on the periodic structure of particle (electrons for the former two and ions for Brillouin amplification) density fluctuations that function as a grating. By turning off the ion motion in particle-in-cell simulations, we can distinguish Brillouin from Raman, and show that Raman amplification is responsible for the main leading spike amplification of ultrashort pulses. By artificially turning off the longitudinal electric field (E_x) in simulations, we can distinguish Raman from Compton-like superradiant amplification. Interestingly, we find that the superradiant amplification in E_x-off simulation is similar to the amplification in pair plasmas, with roughly half amplification efficiency of the latter due to absence of equal contribution from positrons. In addition, we also discuss the competition between Brillouin amplification and superradiant amplification in pair plasmas by comparing the dominance of thermal pressure and ponderomotive force.

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