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Magnetic Field Amplification by a Nonlinear Electron Streaming Instability[1] J. RYAN PETERSON, SLAC National Accelerator Laboratory, Stanford University, SIEGFRIED GLENZER, FREDERICO FIUZA, SLAC National Accelerator Laboratory — Magnetic field amplification by streaming instabilities is central to many astrophysical scenarios, from supernova remnant shocks to gamma-ray bursts. It can also be important in advanced laboratory concepts for inertial fusion and compact radiation sources. The Weibel, or current filamentation, instability is often thought to be the dominant amplification mechanism in weakly magnetized environments, but it operates only at very small (skin depth) scales. We report a new nonlinear electron streaming instability that arises due to the propagation of highly relativistic electrons in a background plasma after saturation of the Weibel instability. This instability gives rise to large cavities in the background plasma that grow radially, leading to exponential amplification of the magnetic field strength and spatial scale over many orders of magnitude. It saturates when the gyroradius of the relativistic electrons becomes comparable to the size of the cavity (Alfvn limit), producing near-equipartition magnetic fields even when the electron beam density is much smaller than the background density. Analytical scalings for the growth rate, wavelength, and saturation amplitude are shown to be in good agreement with multidimensional particle-in-cell simulations.

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