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Phase-mixing self-injection into wakefield acceleration structure driven in a rising density gradient[1] AAKASH SAHAI, Duke Univ — We model the phase-mixing self-injection of electrons into the plasma-wakefield acceleration structures driven in a longitudinally rising density gradient. In several laser-plasma acceleration experiments a long tail of accelerated electrons of different energies is experimentally observed. Self-injection is the process where some of the plasma electrons lose coherence with the wave due to non-linearities. The non-linearity is inherently and intentionally induced in the plasma oscillations due to the variation of the restoring force along the rising density gradient. These electrons then get trapped in and propagate with the accelerating phase of the plasma-wave. The onset of trapping is shown to scale with the gradient of the rising density and the amplitude of oscillations using the phase-mixing model. We computationally verify the phase-mixing model in planar geometry using PIC codes. The trapping of electrons in cylindrical electron plasma oscillations in the non-linear regime is verified with scaling similar to the planar geometry phase-mixing model. A full theory of longitudinal phase-mixing of radial oscillations is currently underway. The importance of this work for laser-plasma acceleration lies in consistently accelerating just the desired mono-energetic bunch.

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