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Ion motion in the proton driven plasma wakefield accelerator JORGE VIEIRA, Instituto Superior Tecnico, Lisboa Portugal, NELSON LOPES, CARLOS RUSSO, Insituto Superior Tecnico, Lisboa Portugal, RICARDO FONSECA, DCTI-ISCTE Lisbon University Insitute, WARREN MORI, University of California, Los Angeles, LUIS SILVA, Insituto Superior Tecnico, Lisboa Portugal — The proton driven plasma wakefield accelerator (PDPWFA) is a novel plasma based accelerator which uses proton bunches to excite large amplitude wakefields. A proposal for a proof-of-principle experiment using the SPS LHC proton bunch at CERN is currently being prepared. The length of the SPS proton bunch is much longer than the plasma wavelength for the typical plasma densities being considered. Thus, in a PDPWFA proof-of-principle experiment, the long proton bunch is self-modulated through the transverse modulation instability, which enhances the amplitude of the accelerating gradients. In this work we explore the role of the ion dynamics in the PDPWFA. We show that the ion motion is driven by a ponderomotive-like force associated with the radial plasma wakefields. Multi-dimensional particle-in-cell simulations confirm the analytical model, and reveal that the ion motion leads to the saturation of the self-modulation instability, thus limiting the accelerating gradients. We show that the ion motion can be avoived by suitably adjusting the plasma density, and by using heavier ion plasmas.

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