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Characterization of wavebreaking time and dissipation of weakly nonlinear wakefields due to ion motion

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In an initially uniform plasma, the lifetime of a weakly nonlinear plasma wave excited by a short driver is limited by the ion dynamics. The wakefield contains a slowly varying radial component, which results in a perturbation of the ion density profile and consequent destruction of the plasma wave. We suggest a novel method of quantitative characterization of the plasma wave lifetime in numerical simulations. The moment of wave breaking is associated with the appearance of fast electrons and, consequently, quick modification of the energy flux in the co-moving frame. The method is precise enough to determine the moment of wave breaking to within a fraction of the plasma wave period. One of interesting results achieved with this method is the power $1/3$ scaling of the wave lifetime with ion mass.

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