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Ion acceleration by intense, few-cycle laser pulses with nanodroplets

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The energy distribution of electron and ion beams emerging from the interaction of a few-cycle Gaussian laser pulse with spherical nanoclusters is investigated by means of 2D PIC simulations with the code EPOCH. It is found that the direct conversion of laser energy into dense attosecond electron nanobunches (Di Lucchio & Gibbon, PRSTAB 18, 02/2015) results in rapid charge separation and early onset of Coulomb-explosion-dominated ion dynamics. The ion core of the cluster starts to expand soon after the laser has crossed the droplet, the fastest ions attaining tens of MeV at relativistic intensities. After comparisons of the ion spectra created by two-cycle with those produced by more standard 16-cycle laser pulses, we find that the two-cycle pulse initially leads to a stronger scaling of the ion energies with laser intensity (~I^{2/3}), saturating at the pure Coulomb explosion limit when the electrons are completely stripped from the cluster (Di Lucchio et al., Phys. Plasmas, 2015, in press). The current investigation should serve as a guide for contemporary experiments using state-of-the-art few-cycle ultraintense lasers and electrically isolated nanoclusters of solid density.

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