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Ion accelerations via the interaction of intense lase pulses with cluster targets

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In order to understand the synergetic interplay between the Coulomb explosion of clusters and the background gas dynamics, an energy spectrum of carbon/oxygen ions from the CO_2 clusters and that of protons from the background hydrogen gas are measured separately at 1×10^19 W/cm^2 with a careful analysis of etch pit structures on CR-39. The maximum energies of carbon/oxygen ions and protons are determined as 1.1 MeV/u and 1.6 MeV, respectively. The structure of electric field and dynamics of contact surface due to the interaction between cluster and background gas are analyzed with help from 2D-PIC simulations. The phenomenon is suggested to have a similarity to a structure formation process in Supernova remnants.
Moreover, we present a development of submicron-size hydrogen cluster targets using a cryogenic conical nozzle and their characterization with the Mie scattering method. Above 10^22 W/cm^2, achievable soon with the coming PW laser facilities, the anisotropic Coulomb explosion of submicron-size hydrogen clusters could produce directional proton beams with energies of several tens of MeV, quite advantageous to the future applications, since they are inherently impurity-free, high rep.rate, and robust.

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