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Post-Laser Radiation Pressure Acceleration: Coulomb Acceleration of Mono-Energetic Protons by Electron-Screened Carbon Ions in Laser Irradiated Multi-Ion Targets CHUAN-SHENG LIU, TUNG-CHANG LIU, XI SHAO, MINQING HE, University of Maryland, College Park, BENGT ELIASSON, Ruhr-University Bochum, Germany, VIPIN TRIPATHI, Indian Institute of Technology, India, JAO-JANG SU, University of Maryland, College Park, JYHPYNG WANG, SHIH-HUNG CHEN, National Central University, Taiwan —
Laser acceleration of monoenergetic protons in a thin hydrocarbon target with protons as a minority species is studied theoretically and by simulation. We found there are two distinct stages of acceleration: radiation pressure acceleration of the target as a whole, followed by electron screened Coulomb repulsion of protons by carbon ions. The instabilities are largely suppressed, and the acceleration time with these combined mechanisms lasts ten times longer than with radiation pressure acceleration alone. We developed analytical theory, solved the proton equations of motion for the screened Coulomb acceleration, and compared with the simulation. Excellent agreement was obtained between the simulation result and the numerical solution. We found that the proton acceleration due to Coulomb repulsion in the second stage is effective. With 10% protons, a proton beam of more than ten billion in number can be accelerated to close to 1 GeV for a laser with less than 7 petawatt power over two hundred laser periods. Novel schemes such as laser switching to further increase the energy of monoenergetic protons in this mechanism will also be discussed.

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