ION ACCELERATION WITH HIGH-CONTRAST, KILOJOULE, PICOSECOND LASER PULSES ON LFEX

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Laser-ion acceleration by a strong charge-separation field generated on a thin foil target is governed by the absorption mechanism of laser energy into electrons. In the interaction between a laser pulse having relativistic intensity and overdense plasma, electrons are anomalously heated beyond the momentum limit in vacuum: $m_e c a_0^2/2$, where m_e is the static mass of electron, c is the speed of light in vacuum, and a_0 is the dimensionless amplitude of the laser. This phenomenon has been investigated intensively by several groups [1–4] revealing that nonlinear motion of electrons takes a predominant role in the anomalous heating.

In this paper, we experimentally investigate the ion acceleration mechanism using kilojoule picosecond laser LFEX [5], the laser contrast of which has been improved drastically. The laser pulse having a duration of 1.5 ps is focused onto an aluminum foil target with an energy of 1 kJ. The areal peak intensity obtained is 1.2×10^{19} Wcm^{-2} (a_0=3.1). The kinetic energy and mass of ions accelerated from the rear side of the target, the thickness of which is ranging from 0.4 to 10 μm, are analyzed by Thomson parabola spectrometer. As a result, protons having energy exceeding 30 MeV are observed using the high contrast laser. Note the observations above have been performed without plasma mirror in the laser path. In a previous energy scaling of ion acceleration [6], 30-MeV protons were obtained with the laser intensity exceeding 10^{20} Wcm^{-2}, which is higher by an order of magnitude than the present one.

To explain the experimental results, we discuss the ion acceleration mechanism via stochastic heating [3,4], where the maximum kinetic energies of electrons and the charge separation field grow as a function of time, indicating that longer duration of the laser pulse can make a beneficial effect on the ion acceleration. In the talk, we show the scaling on the ion energy according to the stochastic mechanism for future investigations.

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