Ion acceleration using self-focusing pulse in near critical density plasma

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Laser-driven ion acceleration has been extensively studied to realize the high energy ion sources for wide applications including cancer therapy [1], high-resolution radiography [2] and fast ignition-fusion [3]. In resent experiment, Higginson *et al*. [4], reported high energy proton exceeding 94 MeV, which is accelerated by the hybrid mechanism of radiation pressure acceleration (RPA) [5] and target normal sheath acceleration (TNSA) [6] with long (τ_{FWHM}~0.9 ps) linear polarized (LP) laser pulse. In this hybrid acceleration mechanism, relativistic induced transparency of the laser pulse causes volumetric heating of electrons, and that effectively enhances the sheath accelerated proton energy. On the other hand, Bin *et al*., [7] reported that self-focusing laser pulse in near critical density (NCD) plasma give rise to significantly enhanced carbon ion energies especially for RPA regime using circular polarized (CP) laser pulse. They also found that double layer target (NCD + solid density target) generates super-ponderomotive electrons with short (τ_{FWHM}~50 fs) LP pulse, and that enhances ion energy [8].

In this study, the double layer target is used for the case of long (τ_{FWHM}~0.4 ps) LP laser pulse. The enhanced ion energy by the super-ponderomotive electron is also confirmed in that case. Furthermore, these high energetic electrons are converged by the self-focusing laser pulse, and that enhances the excitation of a type of beam-plasma instability. The beam-plasma instability is believed to play key role on momentum transfer from electron to ion [9]. The role of excited electrostatic wave is discussed in our presentation.

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