SEPARATION OF ISOTOPES FROM PLASMA-TARGETS BY COUNTERPROPAGATING RELATIVISTIC LASER PULSES *

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Effective separation of a desired isotope of a chemical element among the various isotopes in a certain compound is one of the contemporary scientific challenges that have wide applications ranging from medicine to energy to weapons applications.

Recently, a method for generation of quasimonoenergetic, low emittance fast ion/nuclei bunches of solid densities from plasma-nanotargets by two counterpropagating laser pulses of ultrarelativistic intensities has been proposed [1], based on the threshold phenomenon of particles “reflection” due to induced nonlinear Compton scattering in these fields [2]. Thus, in this process there is a critical value [2] of intensity, depended on particle’s parameters, above which the particle-wave interaction process proceeds strongly in one direction: either stimulated radiation or absorption takes place, in the result of which the mentioned phenomenon of particles “reflection” (or capture -for an internal particle) occurs from the resulting slowed interference wave - moving potential barrier or well, formed by counterpropagating laser pulses.

This critical value of intensity depends on the mass and charge number of an ion, hence, the reflected ions will have essentially different energies after the interaction. So, this phenomenon of threshold nature opens a principally new way for effective separation of isotopes on the ultrashort distances that may be even smaller than a light wavelength.

In this paper we propose a method for effective separation of isotopes with the two counterpropagating laser pulses focused onto a plasma-target that contains various isotopes by the above mentioned mechanism. We have made two-dimensional particle-in-cell (2D-PIC) simulations for the laser pulses of different frequencies and Gaussian transverse profiles and consider various targets of light and heavy atoms. It is shown that the proposed scheme, based on the “reflection” phenomenon of plasma particles from supershort tightly focused laser pulses, can serve as an efficient tool for separation of isotopes from plasma-targets.


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