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Optimization of quasi-monoenergetic ion acceleration by Coulomb explosion on nanosized cluster

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Interaction between the solid-density nano-sized target and the ultra-intense laser of 10^{19}~10^{21}W/cm^2, provides the regime of Coulomb explosion as the formation of high temperature underdense plasma from the instant expelling of the electrons from atoms, instead of the occurrence of secondary processes of collisions and heating. Characteristic scale length of the plasma is way much smaller than electron Debye length that the non-neutrality causes the outward ion acceleration through Coulomb force. For the spherical structure composed of two species of ions, two dimensionless parameters - the charge-over-mass ratio and the charge density ratio - are optimized to maximize the energy coupling efficiency of quasi-monoenergetic ion generation. Fig.1 shows the terminal velocities for ions at each initial position inside nano-cluster under the circumstance of various charge density ratio (β). Fig.2 depicts the energy spectrum in a more straightforward way, where the narrow bands corresponding to the plateau part of velocity curves in Fig.1 also indicate the good monoenergeticity. In addition, for target with inhomogeneous initial density profile, by varying charge density ratio and parameter for density distribution following power law, we can summarize and find an optimal condition to achieve relatively best coupling efficiency (Fig.3), with the help of one dimensional kinetic simulation of ion particles.

Fig.1

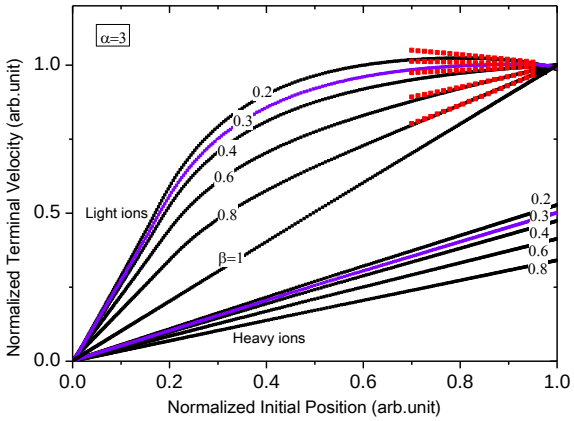

Fig.2

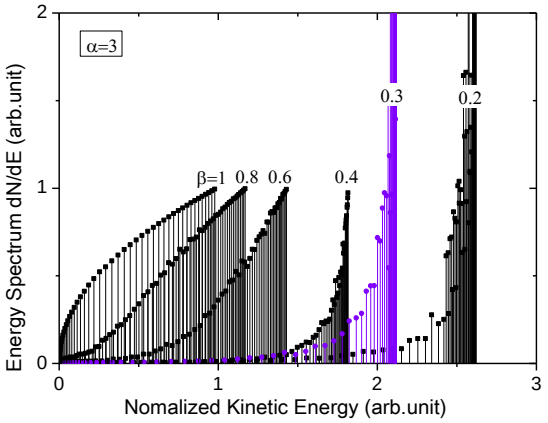

Fig.3