Laser-driven Radiation Pressure Acceleration and Rayleigh-Taylor Instability

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Radiation pressure is an effective mechanism of momentum transfer to charged particles that plays an important role in a wide variety of physical conditions ranging from stellar structures and radiation generated winds, to the formation of ‘‘photon bubbles’’ in very hot stars and accretion disks, to particle acceleration in the laboratory and in high-energy astrophysical environments. The acceleration of a plasma mirror by the radiation pressure of a large amplitude electromagnetic wave is a classical example of relativistic dynamics. Presently, with the advent of petawatt lasers, radiation pressure provides a possible route for accelerating in the laboratory a macroscopic amount of matter up to relativistic velocities corresponding to energies exceeding one GeV per nucleon.

In this presentation we will review recent multi-dimensional analytical and numerical results of the radiation pressure acceleration of a plasma foil that show that the transverse expansion of the target leads to a faster acceleration and to and than higher energy gain than in a planar wave geometry.

The Rayleigh-Taylor instability of the target surface is analyzed and the modification of the linear growth rate due to the modulation of radiation pressure at a rippled surface is calculated. The theoretical findings are compared with the results of three-dimensional simulations.

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