Propagation of intense laser pulses in strongly magnetized plasmas

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Availability of ultra-short ultra-intense lasers has opened new regimes for laser-plasma interactions, which invokes great interest both for the fundamental physics studies as well as for physical applications in areas including particle acceleration, fast ignition of inertial confinement fusion, and radiation sources of different wavelengths. Interaction of such lasers with plasma usually involves nonlinear effects, leading to processes such as laser self-focusing, filamentation of the laser light, production of solitons, electron acceleration and heating, plasma compression and shock generation, etc. Intense lasers can propagate into an inhomogeneous unmagnetized plasma up to the relativistic cutoff density γn_c, where γ is the electron relativistic factor and n_c is the nonrelativistic cutoff density. The propagation of electromagnetic waves can also be strongly affected by the presence of magnetic fields in the plasma.

Propagation of intense circularly polarized laser pulses in strongly magnetized inhomogeneous plasmas is investigated. It is shown that a left-hand circularly polarized laser pulse propagating up the density gradient of the plasma along the magnetic field is reflected at the left-cutoff density. However, a right-hand circularly polarized laser can penetrate deeply into the plasma without cutoff and nonlinearly heat the electrons along its path. Results from particle-in-cell simulations are in good agreement with that from the theory. The results should be helpful for the hole boring scheme for fast ignition inertial confinement fusion. In addition, the electrons can be efficiently heated by the right-hand laser pulse propagation in a strongly magnetized plasmas, thus be favorable for the target normal sheath acceleration of ions.

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