Effects of strong external magnetic field on high-intense laser propagation into dense plasma

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The establishment of method for generating kilo-tesla class magnetic field using high-power laser allows us to perform experiments of high-intense laser plasma interactions (LPI) under strong external magnetic field [1,2]. Such strong magnetic field affects not only fluid dynamics but also fast electrons and laser propagation. Recently, it is proposed that fast electrons of which divergence is very large are guided by kilo-tesla class external magnetic field and heat core efficiently, and related experiments have been intensively performed [3,4]. With recent progress of strong magnetic field generation in laboratory, fundamental studies using such strong magnetic field have been performed and high-intense laser plasma interactions under strong magnetic field have been opened up as new research area. In this study, we pay attention to high-intense laser propagation into dense plasma under strong magnetic field and have conducted two-dimensional Particle-In-Cell (PIC) simulations of high-intense LPI with strong magnetic field.

Target plasma is made of hydrogen and its density profile in x direction consists of preplasma which has exponential profile with scale length of 20 μm and flat plasma with density of 40 n_{cr}. The density profile in y direction is uniform. Applied external magnetic field along the direction of laser propagation, namely x direction, is set to 50 kilo-tesla. Linearly polarized laser that has temporally flattop and spatially Gaussian profiles with spot diameter of 20 μm irradiates the target with normal incidence. At least 500 fs of simulation has been done using 2D PIC code.

According to the linear theory of cold plasma in strong magnetic field, right-handed circularly polarized (RCP) component of electromagnetic wave propagates into dense plasma without cut-off density. Simulation results show that initially RCP component of injected laser can propagate in dense plasma, but after a while following laser cannot propagate. It is found that strong ion acoustic wave generates at the area where laser cannot propagate and it triggers the reflection of RCP component of the injected laser. In the presentation, inhibition mechanism of laser propagation will be discussed in detail.

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