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Laser plasma Interaction: new regime with magnetized electrons

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In the presence of an externally applied magnetic field of about 14 kilo Tesla, the lighter electron species of the plasma would exhibit magnetized behavior while interacting with CO2 laser (which has a wavelength of about 10 microns). For conventional laser of 1 micron wavelength the magnetic field requirement will be 10 times higher. For the magnetized response of the electron species the laser plasma interaction is expected to unravel new features which need to be understood. In particular, the behavior of laser propagation and the associated linear and nonlinear properties of plasma response can be quite distinct from the conventional behavior. The laser propagation, its energy absorption and heating of the plasma medium will get effected. Thus, new physics is expected to emerge from the laser plasma interaction studies in this domain.

Recently, studies in this particular regime using Particle – In – Cell (PIC) simulations have been carried out by our group with the help of OSIRIS4.0 [1]. The results of these studies will be presented in the talk. In particular the parametric regime of lower hybrid (LH) wave excitation is identified. It is noted that the LH excitation in this case is a driven response of plasma in the presence of laser field. This electrostatic mode gets excited as a result of the difference between the electron and ion drifts at the laser frequency along the propagation direction. The LH wave excitation ultimately leads to the laser energy getting preferentially absorbed by the ion species [2]. At high laser intensities these hot ions are observed to form coherent magnetosonic soliton structures [3] which propagate deep inside the target.

With current progress in obtaining high magnetic field of the order of tens of kilo – Tesla in laboratory, it is only a matter of time when it would be feasible to carry out experiments in laboratory to study this particular regime. This would then also open up a variety of technological possibilities in frontier experiments. For instance, this may lead to a smarter design of fusion device which utilizes the best of both magnetic and inertial confinement concepts.

References:

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