Energy coupling via wave-particle interaction in X-mode configuration of a magnetised plasma

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There are several well known mechanisms for the absorption of EM (Electro Magnetic) wave energy into plasma. They depend on collisional as well as resonance processes. In the context of magnetized plasma the cyclotron resonances of the plasma species (e.g. electron-cyclotron resonance heating, ion-cyclotron resonance) are exploited for the purpose EM energy absorption. In a recent study it has been shown that the electrostatic lower hybrid (LH) wave can be excited in a plasma in the presence of an externally applied magnetic field in the X – mode configuration when the laser frequency lies between the electron and ion gyrofrequency [1,2]. The laser was incident on the vacuum plasma surface with a homogeneous overdense plasma density. The laser EM field could propagate inside the overdense plasma as its frequency lied in the pass band of the X mode configuration. The excitation of LH wave led to the irreversible transfer of the EM wave energy to plasma. A significant energy of the wave in this case is observed to get directly transferred to the ion species. In this study, we have identified conditions for maximum energy coupling by proper tailoring of the plasma density profile. Varying plasma density leads to generation of high electrostatic field in plasma at a particular point, leading to coupling of wave energy into particles at that location. This way coupling of EM wave energy into plasma can be achieved in a controlled manner. We have studied in detail the role of inhomogeneous plasma density on the conversion of the energy.

References:

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