Mass ablation and magnetic flux losses in a plasma-wall interface

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Magneto Intertial Fusion (MIF) concepts rely on insulating magnetically the fuel in order to reduce the electron thermal conductivity and relax the implosion velocity and areal density requirements [1]. In 2010, Slutz and collaborators [2] proposed a scenario in which a magnetized cylindrical capsule enclosed by a metallic liner is compressed at 100 km/s by a pulsed-power machine. The attractiveness of this regime, denoted as Magnetized Liner Inertial Fusion (MagLIF), resides in the possibility of designing high gain configurations by adding a cryogenic deuterium-tritium layer in the inner surface of the liner [3].

A key point for MagLIF success is to understand how the magnetic flux losses in the plasma-liner interface are enhanced by the Nernst term even when the plasma is very conductive [4], and how magnetization reduces the effect of the Nernst velocity.

In this talk, the evolution of a hot magnetized deuterium plasma in contact with a cold unmagnetized deuterium wall is analyzed, aiming to represent crudely the plasma-liner interface in a high gain MagLIF configuration. A fluid model is proposed and the transport terms are taken from Braginskii [5]. The solution presents a self-similar structure, in the form of a diffusive wave, depending on two parameters solely: the electron hall parameter x_e and the magnetic Lewis number *Le*, defined as the ratio between thermal and magnetic diffusivities. The wall is treated as a cold magnetic isolant plasma with zero thermal conductivity. Special attention is paid to the effect of the Nernst term. Scaling laws for the dependence of mass ablation and magnetic flux losses with x_e are analytically derived. Effects of finite thermal to magnetic pressure ratio β, usually disregarded in this problem, are taken into account.

References

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