THE INFLUENCE OF MAGNETIZED ELECTRON TRANSPORT ON THERMAL SELF-FOCUSING AND CHANNELLING OF NANOSECOND LASER BEAMS

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The effect of magnetic fields on nanosecond laser-plasma interactions is the subject of recent research interest. For example, externally applied magnetic fields have been used to control plasma density channels in gas-jets [1] and to improve laser coupling into hohlraums in experiments on the OMEGA laser [2]. The B-field is believed to affect these systems by magnetizing electrons ($\omega_{ce}\tau_c>1$) which inhibits electron heat flow across field lines. Supersonic propagation of spontaneously generated B-field from the hohlraum wall into the gas-fill plasma, due to Nernst advection with heat flow, has been recently inferred [3].

We report on simulations of the propagation of nanosecond duration, $\sim10^{14}$ W/cm^2 intensity, IR laser beams through long scale-length under-dense (0.01—0.1n_{cr}) plasma with applied B-field of up to ~10T. To understand the feedback between inverse-bremsstrahlung heating, magnetized electron transport (heat flow inhibition, Nernst advection, etc.), density cavitation and beam diffraction & self-focusing, we have coupled a paraxial wave solver to a 2D MHD code with complete Braginskii electron transport (CTC+ [4]).

Nernst advection of B-field is found to significantly affect thermal self-focusing of the laser beam beyond a few 100ps under the conditions considered. Without Nernst, but all other magnetized transport effects retained, applied B-fields promote self-focusing and channelling. However, inclusion of Nernst can remove this benefit by modifying the B-field, temperature and density profiles in the beam vicinity. We also discuss another consequence of magnetized electron transport; the system is prone to the magnetothermal instability [4]. This arises from a feedback between Nernst advection and Righi-Leduc heat flow (i.e. $\boldsymbol{q}_\wedge = -\kappa_\wedge \hat{\mathbf{b}}\times\nabla T_e$) in marginally magnetized plasma ($\omega_{ce}\tau_c\sim1$). Work is underway to assess the role of non-local electron transport on these processes using equivalent Vlasov-Fokker-Planck calculations with the IMPACT code [5] and will be discussed. The implication of the findings to ICF and other laser-plasma applications are considered.

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