Beam Self-Focusing and Electron Transport Effects in Magnetised Laser-Plasmas

Martin READ [1], Christopher RIDGERS [1], John BISSELL [2] and Robert KINGHAM [3]
1) York Plasma Institute, University of York, UK
E-mail: martin.read@york.ac.uk
2) Department of Physics, University of Bath, UK
3) Blackett Laboratory, Imperial College London, UK

Strong magnetic fields can beneficially affect electron transport in under-dense laser-plasma interactions relevant to laboratory HEDP applications. For example, externally applied B-fields have been used to control low density plasma wave-guide formation [1], to improve laser coupling to gas-filled hohlraums [2], and will affect laser pre-heating in the MagLIF scheme [3]. Changes to electron transport under magnetised conditions cause heat-flow suppression across field lines but phenomena such as the Nernst effect can also lead to changes in B-field dynamics [4] which must be accounted for.

Previously we investigated the effects of magnetised electron transport on the focusing and channelling behaviour of a long-pulse (~1 ns) laser propagating under moderately magnetised plasma conditions ($\omega\tau \sim 1$). The complicated interplay between hydrodynamics, thermal transport, B-field evolution and beam focusing dynamics was investigated computationally in 2D using CTC [5], an MHD code with full Braginskii electron transport coupled to a paraxial wave solving routine. We reported [6] that Nernst advection of B-fields appeared to have a disruptive effect on beam self-focusing but accounting for non-local effects with a full Vlasov-Fokker-Planck treatment (using the IMPACT [7] code) resulted in long-time-scale beam channelling behaviour being retained.

Since then, we have incorporated (some aspects of) non-local effects into the extended MHD calculations by using both a thermal-flux limiter and also an associated limiter on the Nernst advection of magnetic field [8]. Further work is presented here exploring the degree to which use of transport limiters can reproduce the results of full kinetic simulations.

References

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