High-order Wave-based Laser Absorption Algorithm for Hydrodynamic Codes

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Abstract

Collisional laser absorption is typically the main driving mechanism in hydrodynamic laser plasma simulations. Relevance of its modelling multi-folds especially when coupled energy transport mechanisms are involved in realistic simulations [1,2]. Even though, less attention is paid to accuracy and self-consistency of the absorption models. The vicinity of the critical plane, where most of the laser energy is absorbed, cannot be accurately described by any approximation of geometric optics, since plasma profile strongly varies at spatial scale of a single laser wavelength. Only wave-based approaches are correctly applicable in this region in principle [3]. Despite the fact the Helmholtz equation for stationary harmonic waves is well-known from the mathematical and numerical point of view, its direct solution is not feasible in hydrodynamic simulations in many cases. Here, a method directly derived from stationary Maxwell's equations is presented, which encompasses arbitrary polynomial order approximation of the refractive indices by finite elements. The proposed method is completely self-consistent, i.e. relying only on the hydrodynamic quantities, and achieves high order of convergence. However, it still remains computationally inexpensive and sufficiently robust to be usable in numerical codes.

References

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