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A Wave-Based Model for Cross-Beam Energy Transfer in Direct-Drive Inertial Confinement Fusion Implosions

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Cross-beam energy transfer (CBET) is thought to be responsible for an $\sim 30\%$ reduction in hydrodynamic coupling efficiency on OMEGA and up to 50% at the ignition scale for direct-drive (DD) implosions. These numbers are determined by ray-based models that have been developed and integrated within the radiation–hydrodynamics codes *LILAC* (1-D) and *DRACO* (2-D). However, ray-based modeling of CBET in an inhomogeneous plasma assumes a steady-state plasma response, does not include the effects of beam speckle, and ray caustics are treated in an *ad hoc* manner. Nevertheless, simulation results are in good qualitative agreement with implosion experiments on OMEGA (when combined with a model for nonlocal heat transport). The validity of the modeling for ignition-scale implosions has not yet been determined. To address the physics shortcomings, which have important implications for DD inertial confinement fusion, a new wave-based model has been constructed. It solves the time-enveloped Maxwell equations in three-dimensions, including polarization effects, plasma inhomogeneity, and open-boundary conditions with the ability to prescribe beams incident at arbitrary angles. Beams can be made realistic with respect to laser speckle, polarization smoothing, and laser bandwidth. This, coupled to a linearized low-frequency plasma response that does not assume a steady state, represents the most-complete model of CBET to date. New results will be presented and the implications for CBET modeling and mitigation will be described. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DENA0001944, in collaboration with J. G. Shaw, R. K. Follett, and D. H. Edgell (LLE).