The Effect of Magnetic Fields on Cross-Beam Energy Transfer in Laser Driven Hohlraums

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The use of externally applied magnetic fields in indirect drive ICF can boost the ignition process by suppressing thermal conduction losses and increasing alpha particle confinement. Magnetisation may provide more robust or reliable ignition in current ICF designs, as well as a path to ignition of high yield targets. Recent indirect drive experiments on the National Ignition Facility using applied magnetic fields of up to 26 T demonstrated increased ion temperatures and neutron yield with gas filled capsules [J. D. Moody et al., Phys. Rev. Lett. 129, 195002 (2022)].

Magnetic fields also modify the electron heat transport within the hohlraum, for example between the laser absorption region and the region of ablation and soft X-ray emission. Even within hohlraums without externally applied magnetic fields, the self-generated magnetic fields arising from the Biermann effect may be large enough to modify electron heat flow. The effects of magnetised heat transport are most prevalent in regions where the magnetisation parameter is high, i.e. regions of high temperature and low density where the field is magnitude is large. Such conditions exist adjacent to the laser entrance holes where the laser beams overlap and the holhraum fill gas is at high temperature. This corresponds to the region where Cross Beam Energy Transfer (CBET) plays a significant role in controlling the shape of the X-ray drive delivered to the capsule, through the exchange of energy between polar and equatorial beams. The magnitudes of CBET as well as drive deficit remain significant areas of uncertainty in integrated hohlraum and capsule designs.

We present preliminary results from 3D simulations of a copper hohlraum at NIF scale using the extended MHD code Chimera, incorporating a new 3D ray trace laser model with an integrated CBET model. Results are compared for cases with no magnetic fields, with self-generated fields and with applied magnetic fields. Of particular interest are the temperatures and densities of the beam overlap regions close to the laser entrance holes and the effects that changes in these conditions have on CBET and the X-ray drive reaching the capsule.