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Saturation of multi-beams laser plasma interactions by turbulent ion heating[1]

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Overlapping multiple laser beams in plasmas, as is often done in ICF or HEDP experiments, can lead to a rich variety of laser-plasma interactions. In particular, plasma-induced power transfer between overlapping laser beams has been successfully used to tune the implosion symmetry of ignition capsules since the beginning of the National Ignition Campaign in 2009. However, recent experiments have shown that power transfer is saturated, even though the associated plasma waves are typically too small (dn/n$\sim 10^{-4}$) to trigger non-linear saturation mechanisms. In this presentation, we will show that overlapping multiple laser beams in plasmas can lead to strong turbulent ion heating and saturation of laser-plasma interactions. The heating rate is found to be of several keVs/ns, which can have a significant effect on the local hydrodynamics conditions at the entrance holes of ignition targets where the laser beams overlap. The ion heating has also been identified as the main saturation mechanism for cross-beam power transfer observed in NIF experiments, reducing the linear gains by as much as 4-5x. It also prevents reamplification of the stimulated Brillouin scattering generated inside the targets by the incoming laser beams at the entrance holes, which had been a concern for NIF experiments but could never be demonstrated experimentally. This mechanism was investigated using a new 3D "gridless" particle code with binary collisions. A reduced model based on the weak turbulence theory was also developed, and is found to be in good agreement with the particle code's results. The implementation of this reduced model in radiative-hydrodynamics codes will be presented.

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