Impact of Non-Maxwellian Electron Distribution Functions on Crossed-Beam Energy Transfer

DAVID TURNBULL, Laboratory for Laser Energetics

Energy transfer between crossed laser beams is an important process in both the direct- and indirect-drive approaches to inertial confinement fusion (ICF), and unreliable predictions in numerous contexts have raised questions as to the validity of models. Typically, those models require state variable inputs (i.e., $n_e$, $T_e$, and $T_i$) that are computed in radiation-hydrodynamic simulations, which assume Maxwellian electron distribution functions (EDF). However, laser plasma heating is predicted to distort the EDF away from Maxwellian\textsuperscript{2}. Here, measurements of the complete Thomson scattering spectrum indicate the presence of super-Gaussian EDF’s that are consistent with existing theory\textsuperscript{3}. In such plasmas, ion acoustic wave (IAW) frequencies increase monotonically with super-Gaussian exponent\textsuperscript{4}. To match experiments that measured power transfer between crossed laser beams mediated by IAW’s, accounting for the measured non-Maxwellian EDF is required\textsuperscript{5}. This effect is estimated to decrease energy transfer in indirectly-driven hohlraums at the National Ignition Facility by $\approx 27\%$; this will reduce (and may eliminate) the \textit{ad hoc} saturation clamp that has previously been used to match observables like shape, thereby improving the predictive capability of integrated modeling.

\textsuperscript{1}This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0003856.


\textsuperscript{5}D. Turnbull \textit{et al.}, in review (2019).