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Modelling Primary Neutron Spectra in Kinetic Ion Simulations
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— Analysis of primary DD and DT neutron spectra in ICF experiments usually relies on a hydrodynamic approximation in which it is assumed that the reacting ions have a Maxwellian distribution of velocities. This greatly simplifies the kinematics of reacting ions and means the primary spectra shapes are functions of ion temperature and fluid velocity only. The richness of spectra shapes can then be ascribed to temporal and spatial variations of these quantities. However, the validity of the hydrodynamic approximation remains uncertain, particularly for implosions with a low areal density. In this work, this is investigated using kinetic ion simulations of capsule implosions. An algorithm is developed to calculate the primary neutron spectrum for arbitrary ion distributions that are fully-resolved in phase space. The algorithm is deterministic and includes the effects of the differential cross-section, allowing the sensitivity of the primary spectra to the ion distribution function to be accurately studied. The algorithm is implemented in the multi-ion VFP code iFP and implosions are simulated at a range of areal densities in a spherically-symmetric geometry. The neutron spectra from the fully kinetic calculation are compared with spectra calculated using the hydrodynamic approximation.

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