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High-Energy-Density–Physics Studies for Inertial Confinement Fusion Applications*

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Accurate knowledge of the static, transport, and optical properties of high-energy-density (HED) plasmas is essential for reliably designing and understanding inertial confinement fusion (ICF) implosions. In the warm-dense-matter regime routinely accessed by low-adiabat ICF implosions,[1] many-body strong-coupling and quantum electron degeneracy effects play an important role in determining plasma properties. The past several years have witnessed intense efforts to assess the importance of the microphysics of ICF targets, both theoretically and experimentally. On the theory side, first-principles methods based on quantum mechanics have been applied to investigate the properties of warm, dense plasmas. Specifically, self-consistent investigations have recently been performed on the equation of state, thermal conductivity, and opacity of a variety of ICF ablators such as polystyrene (CH), beryllium, carbon, and silicon over a wide range of densities and temperatures.[2–5] In this talk, we will focus on the most-recent progress on these *ab initio* HED physics studies, which generally result in favorable comparisons with experiments. Upon incorporation into hydrocodes for ICF simulations, these first-principles ablator-plasma properties have produced significant differences over traditional models in predicting 1-D target performance of ICF implosions on OMEGA and direct-drive–ignition designs for the National Ignition Facility. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.
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