A Review of High-Energy-Density–Physics Studies for Inertial Confinement Fusion

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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 [1,2] routinely accessed by low-adiabat ICF implosions, many-body strong-coupling and quantum 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 such as path-integral Monte Carlo and quantum molecular dynamics have been applied to investigate static, transport, and optical properties. Specifically, systematic investigations have been performed on the equation of state, thermal conductivity, and opacity of deuterium–tritium (DT), polystyrene (CH), beryllium, carbon, and silicon over a wide range of densities and temperatures, for ICF applications [3–8].

In this talk, we will review the most-recent progress on these HED physics studies. In the warm dense regime, a*b-initio* results, which can significantly differ from predictions of traditional plasma models, generally compared favorably with experiments. Upon incorporation into hydrocodes for ICF simulations, these first-principles plasma properties have produced significant differences over traditional models in predicting 1-D target performance of DT implosions on OMEGA and direct-drive–ignition designs for the National Ignition Facility. Our presentation will focus on reviewing the impacts of the first-principles properties of DT and ablators on the understanding of ICF target implosions [9].

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