Observing the influence of atomic and nanoscale structure on the DC conductivity of warm dense matter

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Understanding WDM is critical for optimizing the Inertial Confinement Fusion trajectory and modeling planetary dynamos. However, predicting WDM properties remains difficult due to the combination of non-trivial degeneracy and strong Coulomb coupling. In addition, the atomic structure is predicted to influence materials in the warm dense matter regime [1-4]; however, experimental data needed to validate such predictions are scarce [5].

Here we present near-zero-frequency (DC) electrical conductivity measurements of warm dense copper determined by THz spectroscopy [6,7]. Copper thin films were heated using intense femtosecond laser pulses to WDM conditions and probed using single-cycle THz pulses. Combining the measured conductivities with temperature estimates based on the Two-Temperature model and Molecular Dynamic Simulation [4], we determine the relevance of the atomistic details and the nanostructure in WD-Cu before and after melting. This represents an important step towards understanding contributions arising from the atomistic details and nanostructure and benchmarking models, which are essential to provide critical tests of computational methods.

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