IRON OPACITY MEASUREMENTS AT SOLAR INTERIOR TEMPERATURES

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Nearly a century ago it was recognized that the attenuation of radiation by stellar matter controls the internal temperature profiles within stars. Opacity calculations, however, have never been benchmarked against laboratory measurements at stellar interior conditions. Opacity of shell dopants used in ICF capsule implosions are also both important and lacking experimental verification. Laboratory opacity measurements have been limited in the past by the challenges of creating and diagnosing sufficiently large and uniform samples at stellar interior conditions. We use the opacity science platform at the Sandia Z facility to measure wavelength-resolved iron opacity at electron temperatures T_e = 156-195 eV and densities n_e = 0.7 – 4.0 x 10^{22} cm^{-3}, conditions very similar to the radiation/convection boundary region within the sun. The measured wavelength-dependent opacity in the 975–1775 eV photon energy range is 30-400% higher than predictions, raising questions about how well we understand the behavior of atoms embedded in high energy density plasma [1]. Furthermore, the measurements help resolve decade-old discrepancies between solar model predictions and helioseismic observations. This talk will provide an overview of the measurements, the numerous investigations of possible errors, and ongoing experiments aimed at testing hypotheses for the model-data discrepancy.

[1] J.E. Bailey *et al.* A higher-than-predicted measurement of iron opacity at solar interior temperatures. *Nature* **517**, 56 (2015).

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