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**Experimental investigation of opacity models for stellar interiors, inertial fusion, and high energy density plasmas**

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Theoretical opacities are required for calculating energy transport in plasmas. In particular, understanding stellar interiors, inertial fusion, and Z-pinches depends on the opacities of mid-atomic-number elements in the 150-300 eV temperature range. These models are complex and experimental validation is crucial. For example, solar models presently disagree with helioseismology and one possible explanation is inadequate opacities. Testing these opacities requires a uniform plasma at temperatures high enough to produce the ion charge states that exist in the sun. Typical opacity experiments heat a sample using x-rays and measure the spectrally resolved transmission with a backlight. The difficulty grows as the temperature increases because the heating x-ray source must supply more energy and the backlighter source must be bright enough to overwhelm the plasma self emission. These problems were overcome using the dynamic hohlraum x-ray source at Sandia's Z facility to measure the transmission of a mixed Mg-Fe plasma heated above 150 eV. This capability will also advance opacity science for other high energy density plasmas. This tutorial describes opacity experiment challenges including accurate transmission measurements, plasma diagnostics, and quantitative model comparisons. The solar interior serves as a focal problem and Z facility experiments are used to illustrate the techniques. **In collaboration with C. Iglesias (LLNL), R. Mancini (U. Nevada), J.MacFarlane, I. Golovkin and P. Wang (Prism), C. Blancard, Ph. Cosse, G. Faussurier, F. Gilleron, and J.C. Pain (CEA), J. Abdallah Jr. (LANL), and G.A. Rochau and P.W. Lake (Sandia). ++Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.