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Experimental Validation of Modeled Fe Opacities at Conditions Approaching the Base of the Solar Convection Zone[1]

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Knowledge of the Sun is a foundation for other stars. However, after the solar abundance revision in 2005, standard solar models disagree with helioseismic measurements particularly at the solar convection zone base (CZB, r $\sim 0.7 \times R_{Sun}$) [Basu, *et al.*, Physics Reports **457**, 217 (2008)]. One possible explanation is an underestimate in the Fe opacity at the CZB [Bailey, *et al.*, Phys. Plasmas **16**, 058101 (2009)]. Modeled opacities are important physics inputs for plasma simulations (e.g. standard solar models). However, modeled opacities are not experimentally validated at high temperatures because of three challenging criteria required for reliable opacity measurements: 1) smooth and strong backlighter, 2) plasma condition uniformity, and 3) simultaneous measurements of plasma condition and transmission. Fe opacity experiments are performed at the Sandia National Laboratories (SNL) Z-machine aiming at conditions close to those at the CZB (i.e. T_e =190 eV, $n_e = 1 \times 10^{23} cm^{-3}$). To verify the quality of the experiments, it is critical to investigate how well the three requirements are satisfied. The smooth and strong backlighter is provided by the SNL Z-pinch dynamic hohlraum. Fe plasma condition is measured by mixing Mg into the Fe sample and employing Mg K-shell line transmission spectroscopy. Also, an experiment is designed and performed to measure the level of non-uniformity in the Fe plasma by mixing Al and Mg dopants on the opposite side of the Fe sample and analyzing their spectra. We will present quantitative results on these investigations as well as the comparison of the measured opacity to modeled opacities.

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