LABORATORY OPACITY MEASUREMENTS AT CONDITIONS APPROCHING STELLAR INTERIORS

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Opacities are an essential ingredient of stellar models and opacity models have become highly sophisticated, but laboratory tests have not been done at the conditions existing inside stars. This hinders present understanding of stars. For example, solar models presently disagree with helioseismic observations and one possible explanation is that opacity models under-predict the true opacity of the solar interior matter. Furthermore, the rapid growth of asteroseismology has raised the importance and scrutiny of stellar opacity knowledge for stars outside our solar system. Our research is presently focused on measuring Fe opacity at conditions relevant to the base of the solar convection zone, where the electron temperature and density are believed to be 190 eV and 9×10^{22} e/cc, respectively. The opacity science platform at the Z facility was used to volumetrically heat tamped iron samples to $T_e = 195 \pm 6$ eV at a density $n_e = 4.44 \pm 1.56 \times 10^{22}$ cm^{-3}. We measured the frequency-resolved opacity with typical uncertainty of approximately ± 10% over the 935 – 1550 eV range using the approximately ~ 370 eV Planckian backlight produced by the dynamic hohlraum source. The sample spatial uniformity was directly measured using tracer layer spectroscopy. The measured opacities are reproducible and satisfy the expected scaling with areal density. The comparison of the measurements with opacity model calculations, the implications for our understanding of atoms in plasmas, and the possible impact on stellar physics will be discussed.

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