Systematic measurements of opacity dependence on temperature, density, and atomic number at stellar interior conditions

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Model predictions for iron opacity are notably different from measurements performed at matter conditions similar to the boundary between the solar radiation and convection zones [J.E. Bailey et al., *Nature* **517**, 56 (2015)]. The calculated iron opacities have narrower spectral lines, weaker quasi-continuum at short wavelength, and deeper opacity windows than the measurements. If correct, these measurements help resolve a decade old problem in solar physics. A key question is therefore: What is responsible for the model-data discrepancy? The answer is complex because the experiments are challenging, and opacity theories depend on multiple entangled physical processes such as the influence of completeness and accuracy of atomic states, line broadening, contributions from myriad transitions from excited states, and multi-photon absorption processes. To help determine the cause of this discrepancy, a systematic study of opacity variation with temperature, density, and atomic number is underway. Measurements of chromium, iron, and nickel opacities have been performed at two different temperatures and densities, and the opacity analysis method has been substantially improved. The collection of measured opacities provides constraints on hypotheses to explain the discrepancy. We will discuss the new analysis method, implications of measured opacities, experimental errors, and possible opacity model refinements.

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