SPECTRAL LINE SHAPES FOR IRON OPACITY AT SOLAR INTERIOR CONDITIONS

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Measurements of photon-energy resolved iron opacities performed in experiments at the Z facility of Sandia National Laboratories in the photon energy range from 950eV to 1750eV have found significant discrepancies with theory predictions. The plasma conditions are characteristic of the boundary between radiation and convection regions in the sun, i.e. electron temperature $T_e \approx 195$eV and density $N_e \approx 1\times10^{23}$cm^{-3}. These experiments are important to help resolve the decade-old discrepancy between results obtained with solar physics models and helioseismic observations [1]. Spectral line shapes play an important role in the calculation of photon-energy dependent opacities. In particular, we investigate the impact of detailed Stark-broadened line shapes on the contribution to the opacity of L-shell transitions in Ne-like Fe ions. Specifically, transitions linking the ground state $1s^2\ 2s^2\ 2p^6$ and excited states where a single 2s or 2p electron was excited into $n > 2$. The calculations were done with the multi-electron radiator line shape model and code MERL that takes into account the effects of the plasma microfields due to ions and electrons [2,3]. The effect of the ions was calculated in the static ion approximation while that of the electrons using a quantum-mechanical second order, relaxation theory. The ion microfield distribution was computed with the APEX model [4]. These results illustrate the importance of both ion and electron broadening effects on iron line shapes of L-shell transitions, and permit an assessment of the impact of field mixing of atomic states driven by the static ions.

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