#52

Using K-shell S line ratios to measure the plasma temperature in a transient FeS plasma

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This talk describes how the steady state atomic kinetics approximation can underestimate the electron temperature determined from K-shell lines in ps-time-scale transient plasmas. In particular we model the inferred temperature evolution of solid FeS targets used in opacity experiments at the Orion laser facility determined from the ratio of the sulfur He-alpha to Ly-alpha lines. Initially we model the constant density steady state scenario and then expand this to include the time dependent density effects. The Orion experiments use short-pulse lasers to heat a thin microdot of FeS buried in a plastic target to temperatures of more than 1 keV and densities of approximately $1 - 2$ g/cm^3 after the FeS quickly equilibrates with the density of plastic. Using atomic kinetics calculations based on the temperature and density history from a radiation hydrodynamic simulation of the target evolution, we show how the peak temperature inferred from the sulfur line ratios is both lower and temporally lags the input temperature history. We then discuss how opacity effects impact the analysis and consider whether other materials may be optimal temperature diagnostic for different temperature ranges.

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