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Raman shifts and plasma screening in warm dense copper

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We show data and first analysis of a recent (Feb 2022) experiment on the spectroscopic investigation of XFEL-heated Cu foil targets. Cu foils were irradiated by the tightly focused XFEL beam (≈1 µm focus, up till 300 µJ in energy, European XFEL), which heats the target to approximately 100 eV during its duration (≈25 fs). The XFEL photon energy was varied in the range $8.8 - 9.8$ keV to scan resonances and K edges of various charge states; three spectrometers were observing the emission Kα and Kβ lines and their satellites. The experimental data are compared to the SCFly simulations and the details are analyzed by using the FAC atomic code.

First of the many interesting phenomena, the shift of the Kα satellite lines is discussed. Each of the Kα lines from ions with different occupancy of the L sheel is shifting both due to the charge state of the emitting ion (i.e. number of electrons in M shell) and due to electron temperature via plasma screening. Both these shifts are experimentally observed and well described by using the FAC calculations. The observed shifts of the absorption K edges are also observed and agrees well to the Stewart-Pyatt model newly included in the FAC code, when the temperature parameter is adjusted to account for the strongly non-thermal electron distribution.

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