High-resolution X-ray spectroscopic study of copper Kβ and Kα lines in relativistic fs-laser produced plasmas: atomic population PIC-simulations and atomic structure MCDF-studies

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Spectroscopic study of X-ray lines generated in laser produced plasma is fundamental for a unique understanding of non-Maxwellian, non-LTE and non-stationary phenomena. The generation of suprathermal electrons, their propagation in dense matter and their temporal evolution is of central interest for plasma atomic physics and the fusion science. In addition the impact of hot electrons on ionizing matter drive important perturbation of almost all radiative properties.

We report on a study of the copper Kα and Kβ X-ray emission conducted at the fs-laser facility JETI40, Jena, Germany. Thin foils have been irradiated by very intense 1ω and 2ω pulses ($I>10^{20}$ $W.cm^{-2}$). A spherically bent quartz Bragg crystal spectrometers with high spectral and spatial resolution have been set up to study the evolution of various copper ionization states via the X-ray emission of Kα and Kβ. A 1340x1300 pixels PI-MTE CCD camera has been used as a detector. Coupled with Single Photon Analysis (SPA), we have been able to detect extremely low X-ray signals with high confidence levels enabling to study ionic fractions as low as 10^{-3}. The spectroscopic results are compared with PIC simulations.

In addition, the high spectral resolution ($\lambda/\delta\lambda > 3000$) of our spectrometer allows us to study in detail K-alpha and K-beta structures. We present first relativistic atomic structure calculations to study red wing Kα-emission and blue shifts [1,2] of open 3d-shell ionization states.

References

[1] F.P. Condamine et al., AIP Conference Proceedings **1811**, 06001 (2017)

[2] F.P. Condamine et al., J. Phys. Conf. Ser. **717**, 012060 (2016)