Determination of transition energies, widths and intensity ratios of few-electron highly-charged ions with a two-crystal x-ray spectrometer

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Abstract:
In the last few years it has become possible to perform accurate, reference-free measurements of transition energies in few-electron ions, like He-like, Li-like, Be-like and B-like sulfur and argon, by using the x-ray emission of the plasma of an Electron-Cyclotron Ion Source (ECRIS) and a double-crystal x-ray spectrometer [1]. Accuracies of 2 to 6 ppm have been achieved for transition energies [2-4], providing among the most accurate transition energy measurements of highly-charged ions. We also measured line widths and intensity ratios, providing tests of radiative and Auger transition probability calculations. We have found a significant disagreement between theory and experiment for the $1s\,2s\,2p\,^2P_{1/2,\,3/2}\rightarrow 1s^2\,2s\,^2S_{1/2}$ in Li-like sulfur and argon [4].
Thanks to the observation of the $1s\,2s\,^3S_1\rightarrow 1s^2\,^1S_0$ M1 forbidden transition, which is very bright in ECRIS plasmas and has a very narrow natural width (e.g., ~10^{-9} eV for a transition energy of 3.1 keV in Ar), we have been able to measure the plasma electronic temperature. By measuring this M1 transition in He-like sulfur, where our energy dispersion is quite large, we have found that we are sensitive to the crystal reflectivity profile, and can distinguish between different models. I will discuss these measurements in few electron ions [1-4], and ongoing work with exotic atoms [5], that can further our understanding of quantum electrodynamics as well as provide fundamental x-ray parameters useful for applications.

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