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Single and multiple photoionization of W^{q+} tungsten ions in charge states q=1,2,..,5: experiment and theory

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Synopsis Absolute cross sections for single and multiple photoionization of W^{q+} ions have been measured in a photon-ion merged beam setup employing synchrotron radiation from the Advanced Light Source. The experimental data are compared to large-scale close-coupling calculations within the Dirac-Coulomb R-matrix (DARC) approximation.

In a previous communication [1] we presented measurements on photoionization (PI) of W^{q+} ions in charge states q =1,2,3, and 5. Here we report on measurements for single and multiple ionization of W^{q+} ions (q=1,2,..,5) by synchrotron radiation and on single-ionization R-matrix calculations for q=1,2,3,4. The experiments were carried out at the photon-ion merged-beam facility of the Advanced Light Source. Absolute cross sections were measured covering energy ranges from below the respective thresholds to typically well beyond 100 eV. The resolution was chosen to be between 100 and 500 meV. PI signal below the ground-state ionization threshold indicate the presence of metastable components in the parent ion beam. This is particularly evident for the W^{5+} ion. The resulting number of states to be considered in this case requires a very substantial effort for a theoretical treatment.

While the PI spectra of W^{1+}, W^{2+}, and W^{3+} are characterized by very broad peak structures a transition to narrow resonance features starts with W^{4+} and leads to a very complex PI resonance structure in W^{5+}. The theoretical results are obtained by large-scale close-coupling calculations within the Dirac-Coulomb R-matrix approximation (DARC) [2, 3, 4]. By including 52 levels for the $5s^2\ 5p^6\ 5d^2\ ^3F_J$ ground state configuration and assuming a statistically weighted distribution of ions in states with $J = 2, 3, 4$ suitable agreement with the experiment is obtained. A comparison of experimental and theoretical data is provided in figure 1 for single photoionization of the W^{4+} ion. Calculations including 385 instead of 52 states are presently underway.

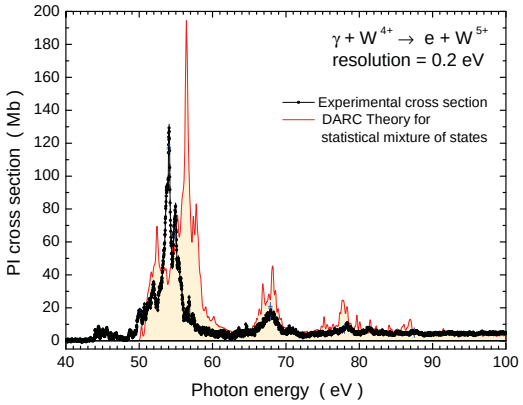

Figure 1. Comparison of cross sections for photoionization of W^{4+} ions on an absolute scale. The theoretical curve resulted from a 52-state close-coupling calculation.

References

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