

A SCALING LAW FOR DOUBLE PHOTOIONIZATION

P. Juranic¹, J. Nordberg², and R. Wehlitz¹

¹ SRC, UW-Madison, 3731 Schneider Dr., Stoughton, WI 53589

² Gustavus Adolphus College, St. Peter, MN 56082

Photoionization of atoms by a single photon may lead to not only singly charged but also doubly charged ions due to electron correlation. The double-to-single photoionization ratio is a convenient measure of this electron correlation. The noble gases have been studied well but, unfortunately, rather close above the first double-ionization threshold other double-ionization thresholds exist and make a comparison to theory difficult. Furthermore, elements heavier than helium can become double ionized via Auger decay (or autoionization). However, Auger decay, which can be viewed as a two-step process, does not depend on electron correlation between the two emitted electrons, as it is the case for the simultaneous emission of electrons.

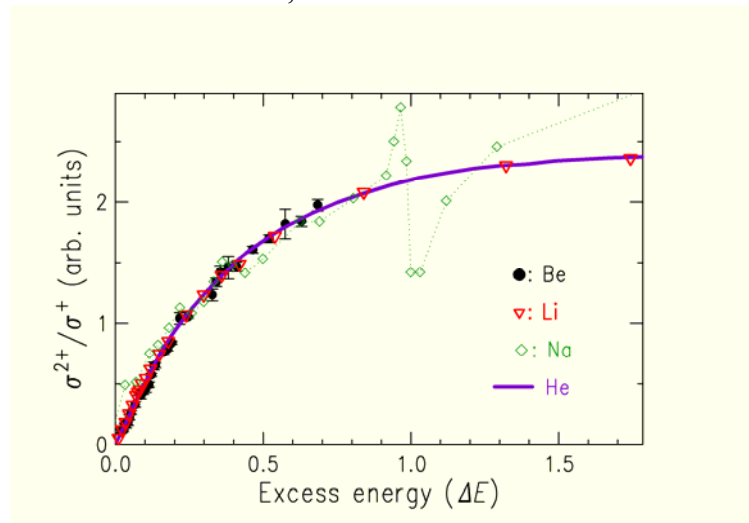


Figure 1: Double-to-single photoionization ratio as a function of excess energy in units of ΔE . ΔE is the energy difference between the double- and single-ionization threshold for the corresponding element.

We have measured precise double-to-single photoionization ratios of lithium, beryllium, sodium, and potassium near threshold, i.e., at photon energies low enough so that (mostly) two-step processes can not contribute to double photoionization cross section. A previously determined scaling law [1] allowed us to conveniently compare the energy dependence of the double-to-single photoionization ratio by scaling the energy axis. Now, we have also found a scaling law that enables us to predict the absolute double-to-single photoionization ratio.

It turns out that the maximal ratio R_{\max} for each element is determined by the square roots of the double-ionization threshold (E_2) and the single-ionization threshold (E_1), i.e. the $R_{\max} (\%) = E_2^{1/2} - E_1^{1/2}$, with E_1 and E_2 given in eV [2]. If electrons from two different shells are involved in the double-ionization process (e.g., Li), the single-ionization threshold of the deeper shell was used as it was also used for the energy scaling. Using the energies in eV is convenient, because then the calculated ratio happens to be in percent (which is purely accidental).

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References:

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