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Title: MULTIPLE ELECTRON CAPTURE IN CLOSE ION-ATOM COLLISIONS*

Author: Alfred S. Schlachter

Address: Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720
USA

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The cross section for multiple-electron capture has been observed[1] to exceed that for single-electron capture in close collisions of fast (47-MeV) Ca^{17+} ions with Ar atoms; the condition for selecting close collisions is observation of a coincident Ca K or Ar K x-ray. A large number of electrons is transferred to the projectile in a single close collision when the Ca-ion projectile velocity is of the order of the Ar L-shell electron velocity. The total cross section, however, for capturing more than one electron in a single collision, is much smaller than that for capturing one electron. This effect does not appear to have previously been seen using emission of an x-ray as a selector of a close collision, with the exception of the observation of double K-to-K transfer in collisions of fast bare Si ions with Ar.[2] Electron capture in close collisions has previously been explored[3] by scattering of the projectile through large angles, or, less directly, by coincidence with production of highly charged recoil ions.

The result for 47-MeV Ca^{17+} in Ar is shown in Fig. 1, in which the cross section for electron capture in coincidence with a Ca K or Ar K x-ray is shown as a function of the number of electrons captured. We have verified that single-collision conditions applied up to the maximum target thickness at which measurements were made. The largest cross section is for capture of four electrons for coincidence with an Ar K x-ray and for capture of three electrons in coincidence with a Ca K x-ray. The effect of multiple electron has also been observed in Ne and Kr targets. Multiple electron capture decreases with increasing projectile velocity.

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We find[1] that the data in Fig. 1 can be described by a binomial distribution.[4] We show in Fig. 2 the probability for electron capture for 0 to 8 electron calculated using the binomial distribution and fit to the experimental values observed for capture of 1 to 5 electrons; the results are shown for electron capture in coincidence with an Ar K x-ray. Similar results are obtained for coincidence with a Ca K x-ray if the values is shifted to the right by 1, i.e., if the number of captured electrons is increased by 1. We explain this by a description of vacancy production by molecular-orbital interaction and K-to-K vacancy sharing. We find an electron-capture probability of 0.52 for electron capture in coincidence with both Ar and Ca K x-rays.

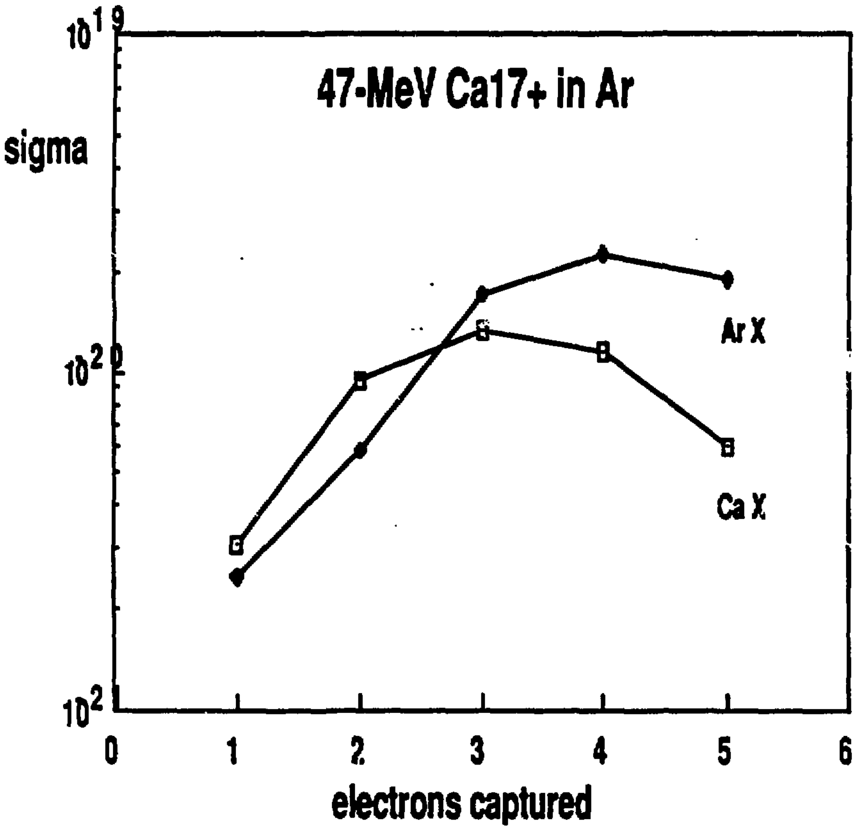

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Fig. 1 Cross section for electron capture in coincidence with Ca K or Ar K x-ray emission as a function of the number of electrons captured, for 47-MeV Ca^{17+} colliding with Ar.

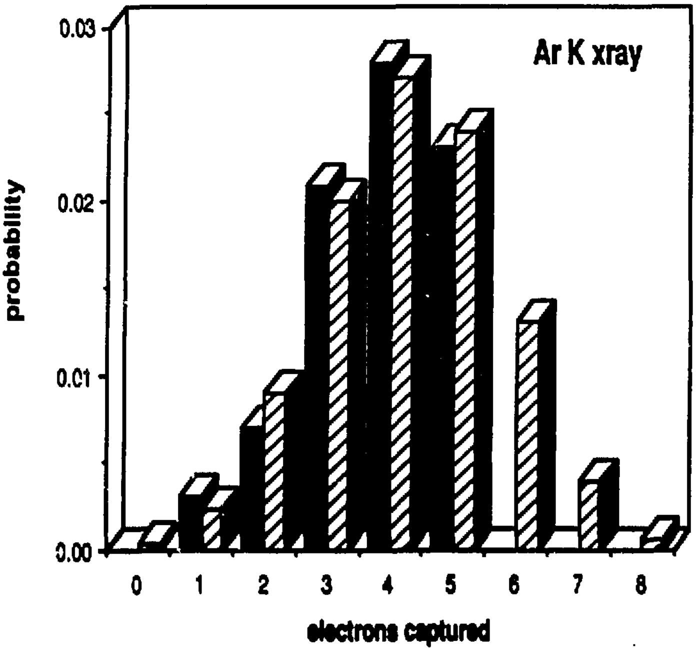

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Fig. 2 Probability of electron capture in coincidence with an Ar K x-ray. Experimental values are shown as a solid, the binomial distribution fit to these values is shown shaded.

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3. See, for example, E.N. Fuls, P.R. Jones, F.P. Ziemba, and E. Everhart, Phys. Rev. 107, 704 (1957); and B. Rosner and D. Gur, Phys. Rev. A 15, 70 (1977).

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