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COLLECTIVE ELECTRON CAPTURE IN CLOSE ION-ATOM COLLISIONS

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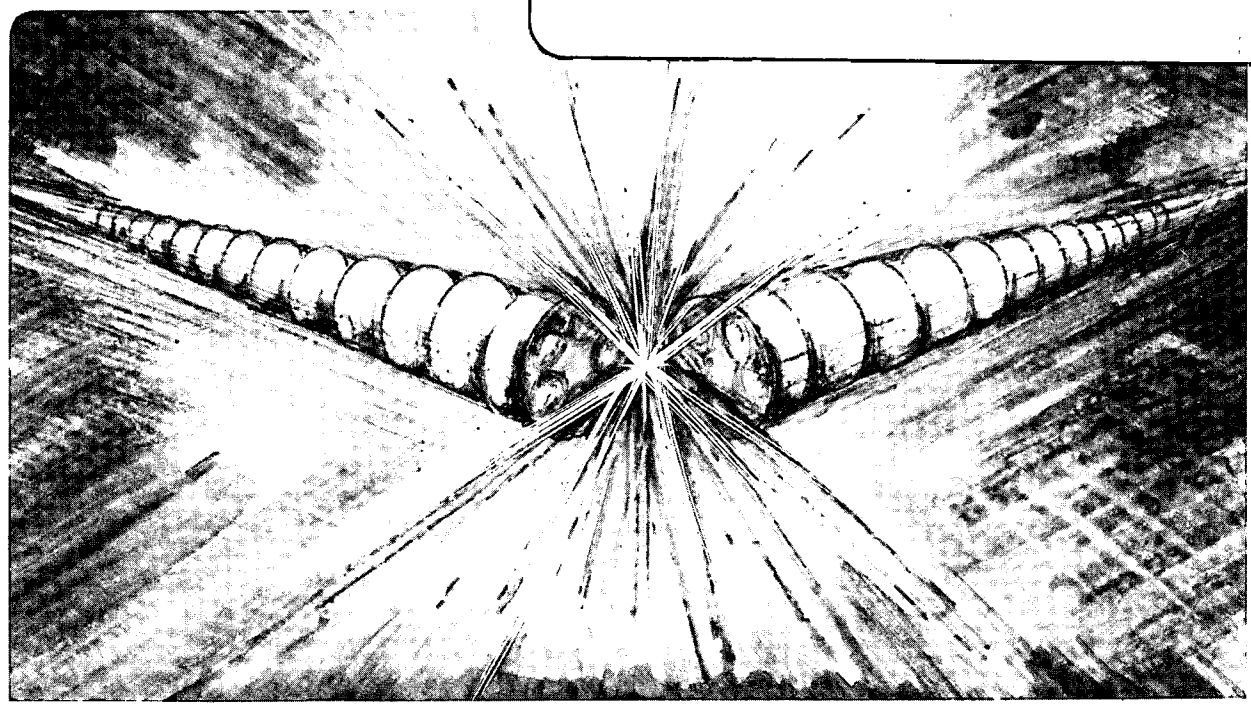
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Collective Electron Capture in Close Ion-Atom Collisions

A.S. Schlachter

October 1987

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

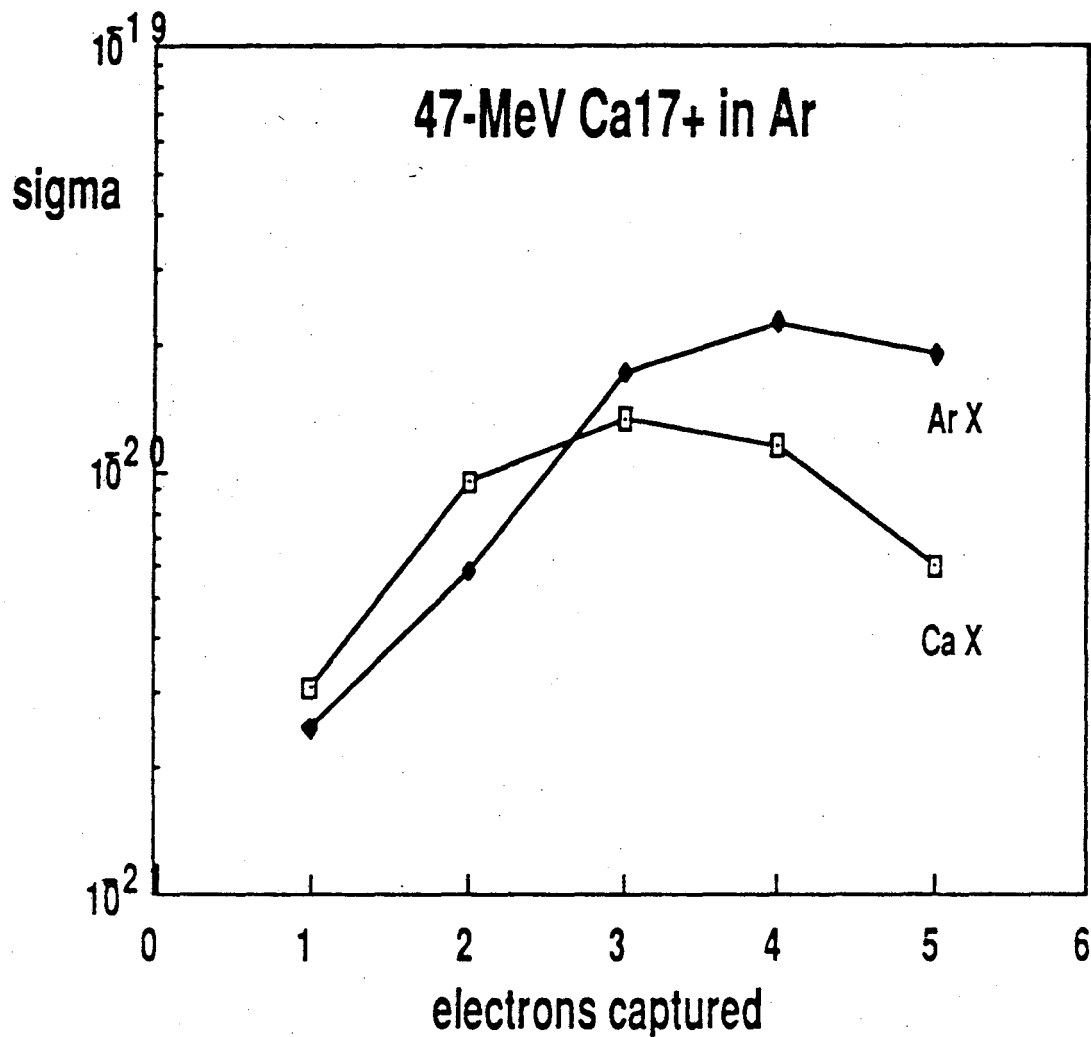
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The cross section for multiple-electron capture has been observed¹ to exceed that for single-electron capture in close collisions of fast (47-MeV) Ca^{17+} ions with Ar atoms; the condition for selecting close collisions is observation of a coincident Ca K or Ar K x-ray. This result is surprising, as the total cross section of capturing more than one electron in a single collision has never been found to be nearly as large as that for capturing one electron in a fast ion-atom collision. The x-ray observed is the result of a K vacancy produced in a close collision in which the impact parameter is of the order of the projectile or target K-shell radius. Close collisions have previously been explored² by scattering of the projectile through large angles, or, less directly, by coincidence with production of highly charged recoil ions. For Ca-ion projectile velocities of the order of the Ar L-shell electron velocity it appears that a large number of electrons is transferred to the projectile in a single close collision, an effect we call¹ collective electron capture. This effect does not appear to have previously been seen using emission of an x-ray as a selector of a close collision.

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 carefully 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 collective electron has also been observed in Ne and Kr targets; it is observed to decrease with increasing projectile velocity.

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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 Ca¹⁷⁺ colliding with Ar.

1. A.S. Schlachter, E.M. Bernstein, M.W. Clark, R.D. Dubois, W.G. Graham, R.H. McFarland, T.J. Morgan, D.W. Mueller, K.R. Stalder, J.W. Stearns, M.P. Stockli, and J.A. Tanis, submitted for publication.
2. 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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