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LOW ENERGY ELECTRON CAPTURE BY MULTICHARGED IONS FROM HYDROGEN*

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Charge exchange with hydrogen is an important recombination mechanism for tokamak impurity ions and can affect plasma parameters and the interpretation of diagnostic results. In an effort to systematically investigate the behavior of low energy electron capture cross sections, we have measured cross sections for $Xe^{(2-12)+}$, $Ar^{(2-9)+}$, and $Fe^{(5,6)+}$ in H and H_2 for $3 < E < 26$ keV/charge, and for $C^{(3-5)+}$ in H_2 for $0.15 < E < 0.45$ keV/charge.

Figure 1 shows the experimental electron capture cross sections for $Xe^{(3-12)+}$ and $Ar^{(3-9)+}$ in atomic hydrogen plotted against initial ionic charge q for a fixed collision velocity. The scaling of cross sections with q follows the generalized theories[1,2] quite well, but measurements are lower than predicted, and data for higher q are needed to further test the theoretical scaling. In a forthcoming paper,[3] additional dependences on ionic species and target electron binding energy are discussed.

Electron capture cross section data for $C^{+q} + H_2$ collisions (q = 3,4,5) have been obtained at much lower impact energies using a laser-produced plasma as an ion source and a time-of-flight technique. Figure 2 compares these data to data obtained at higher energies using other sources of multicharged ions.[4,5] It is significant that C^{4+} has the largest cross section at the very lowest velocities, counter-indicating a simple scaling with ionic charge. The cross sections for charges 3, 4, and 5 also all increase with decreasing velocity in this region. Measurements will be extended to O^{+q} and Fe^{+q} ions and to an atomic hydrogen target to provide a direct comparison with emerging models of low energy charge exchange.[6]

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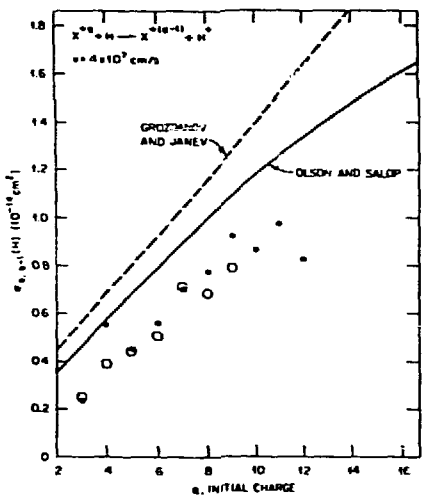

Fig. 1 Electron capture cross sections vs ionic charge q for Xe^{+q} (open circles) and Ar^{+q} (solid circles) in atomic hydrogen at fixed velocity. Scalings predicted by generalized theories are shown for comparison.
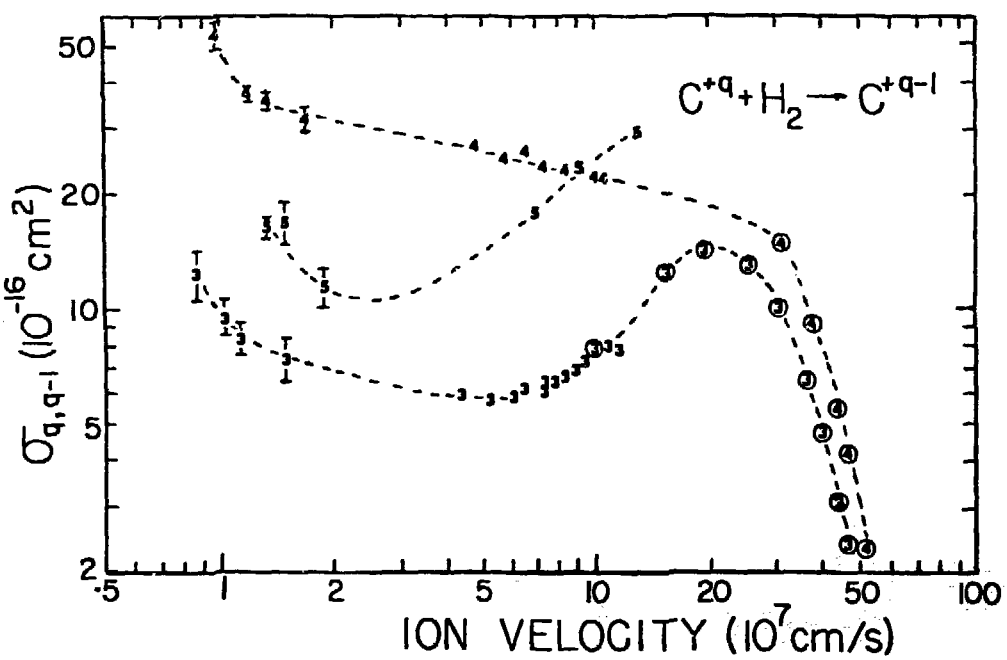
Fig. 2 Electron capture cross sections vs ion velocity for $C^{+q} + H_2$ collisions. Numbers on graph denote q. Circled points are taken from Ref. 5; numbers without flags from Ref. 4. Numbers with flags are unpublished data using laser ion source.