Single electron transfer in 10 to 150 keV $H^+ + Ar$ collisions

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Single electron capture from low to intermediate collisions energies is important in fundamental studies and in a variety of applications such as astro- and plasma-physics and material science [1]. A number of experimental works have been done which involves H^+ as projectiles and an Ar gas as target which cover an ample energy range [2]. At lower energies the two state approximation have yield satisfactory results for H^+ passing through Ar [3], but at intermediate energies several competing channels should be taken into account to give a meaningful picture of the reaction. This studies report total as well as differential cross sections and also the formation of hydrogen excited states

In this presentation we discuss the total and partial calculated cross sections for single electron capture of H^+ on Ar. We use the semi-classical impact parameter method, over the projectile energy range 10-150 keV. While the nuclei follow classical straight-lines, the one active electron motion is found by solving the time dependent Schrödinger equation with the two center atomic orbitals close-coupling method [4]. We used the Coulomb potential between the electron and the proton and an effective potential centered on the Ar nucleus, of the form

$$V(r) = -\frac{Z_0}{r} + (Z_1 + Z_2\ r)\ \frac{e^{-Z_3\ r}}{r}. \qquad (1)$$

The Z parameters are fixed by reproducing the orbital energies of the atom. The basis used for the calculations consist of all n=1-4 H orbitals at the hydrogenic center, as well as 3s, 3p, 3d, 4s, 4p and 4d orbitals at the Ar center. Our cross sections are the result of a simple particle independent model which considers twice the sum of transfer cross sections from all 3p sub-shells to all H states contemplated.

The resulting total cross sections are in good agreement with, although systematically above of, previous experimental data Fig. 1. Calculating sections at energies below 10 keV reveals the inadequacy of a semi-classical treatment. Partial cross sections agree in shape and order of magnitude with measurements at high energies, while at low energies the experimental data is found to be approximately six times smaller than the present results.

Acknowledgments. This work was supported by DGAPA IN-100392 and CONACyT 32175-E.

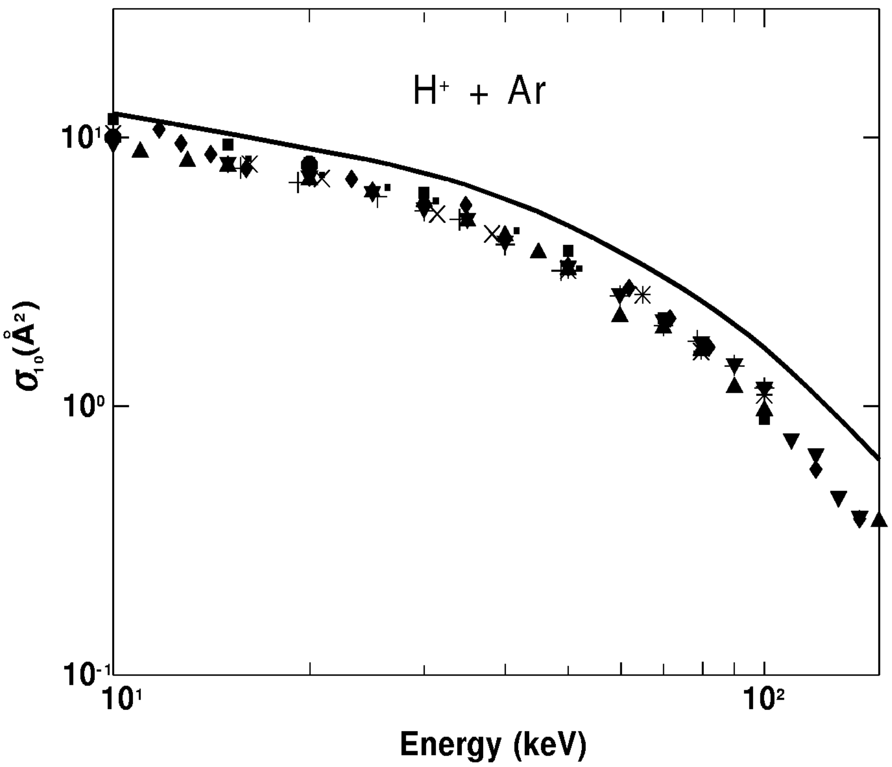

Figure 1: Single capture cross sections. - Present data; × Stedeford; ◇ Stier; △ Allison; ∇ De Heer; Williams; • Schryber; ∗ Tawara; + Rodbro; □ Rudd.[5]

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