# SINGLE AND DOUBLE ELECTRON CAPTURE CROSS SECTIONS AT VERY LOW ENERGIES

by

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# ABSTRACT

Measurements of charge transfer for very low energy highly charged ion-atom collisions are an important topic of study to deepen our fundamental understanding of the mechanisms of collision processes. There is a relatively small amount of data on this subject that is available to assist in improving existing theories, and many of the existing theories are in disagreement with each other. Beyond the "pure science" motivation for studying charge transfer dynamics at low energy, there are many applications where knowledge of the charge exchange process is needed. Astrophysical and fusion plasmas both can have temperatures that correspond to collisions in the range of a few eV/amu to a few hundred eV/amu, and studies of cross sections are important for diagnostics and modeling of these plasmas.

In this research project, a **C**ryogenic **E**lectron **B**eam **I**on **S**ource (**CRYEBIS**) is used to produce a highly charged ion beam, which is directed into an **O**cta-**P**ole **I**on beam **G**uide (**OPIG**), which is used to decelerate the ion beam and guide it, so that the ions do not diverge as they pass through the collision region. Net single and double electron capture cross sections have been measured, at energies ranging from a few eV/amu to a few hundred eV/amu, for the following ion-atom collision systems: $Ar^{(5-11)+}$+ He, $Ar^{(5-11)+}$+ $H_2$, $N^{(3-7)+}$+ $H_2$, $Ne^{(5-9)+}$+ He, $O^{2+}$+ He, $O^{2+}$+ $H_2$, $O^{2+}$+ Ar, and $O^{2+}$+ Ne, and $Xe^{26+}$+ $H_2$.

The measured single capture cross sections are about an order of magnitude greater than the double capture cross sections. In general, the magnitude of both the single and double electron capture cross sections changed very little as a function of collision energy for the range of energies studied. A model independent of collision

energy, the Classical over-barrier model, is in good agreement with the measured single capture cross sections, and has been used to compare our results.