ION-ATOM COLLISIONS USING MERGED BEAMS

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Current studies of electron-capture processes are motivated by the fact that they constitute reaction channels of fundamental importance in plasma environments, such as in fusion devices and stellar plasmas. The merged-beams technique[1] is unique in its ability to accurately explore the electron capture processes for multicharged ions on neutral species at low eV/u energies. Currently absolute total cross sections measurements investigate collisions with ground state H or D from meV to KeV energies. Relative state-selective cross sections are now also possible[2] and provide more detailed information.

Measurements[3] of B^{4+} with H atoms at eV/u energies (60-120 eV/u) have resolved discrepancies between two semiclassical coupled channel molecular-orbital calculations, which differ by 30% with respect to each other over the entire energy range, and between two previous measurements at higher energies which differ by a factor of two. For low charge states ions, competing reaction channels can lead to pronounced structure in the total cross section, as was observed for N^{2+} measurements.[4] Structure observed in the total cross section measurements[5] for C^{4+} + H has yet to be explained by theory and has provided a critical benchmark for comparison. Measurements with ions containing even a small fraction of metastable states can lead to erroneous results. ORNL merged-beams measurements[6] and molecular-orbital theory[6] (shown below) for C^{+} are significantly lower at eV/u energies compared to previous measurements which were probably contaminated with a small amount of metastables in the C^{+} beam.

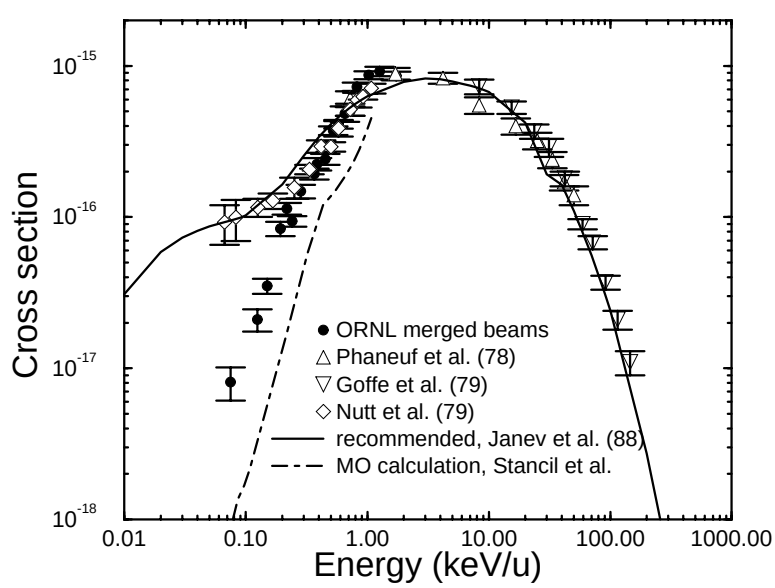

Fig. 1. Comparison of ORNL ion-atom merged beams measurements with other measurements and theory.

The ability to measure accurate total electron capture cross sections coupled with the ability to determine state-selective cross sections provides an important tool to our understanding of electron capture processes. Plans are underway to replace the current H^- duoplasmatron with a commercially available negative ion sputter source. This will make available a variety of neutral targets such as Li, O, S, Fe, O_2, and CH_2 in order to permit exploration of electron capture from multielectron targets where accurate, *ab initio* coupled-channel calculations are generally not available.

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