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ELECTRON CAPTURE BY MULTICHARGED IONS AT eV ENERGIES

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Résumé

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Abstract - A multicharged ion-atom merged-beams apparatus has been used in conjunction with the ORNL-ECR ion source to measure accurate absolute electron-capture cross sections in the energy range from below 1 eV/amu to 1500 eV/amu. Measurements for $N^{3+,4+,5+}$ + H(D) collisions indicate good agreement with available theoretical calculations. However, measurements with O^{5+} + H(D) show an unexpected low-energy behavior which may be attributable to the ion-induced-dipole attraction between the reactants. Scaled Landau-Zener calculations presented here identify a transfer plus excitation channel which has the correct energy dependence at low energies. This finding suggests the need for a comprehensive coupled channel calculation which would include such product states.

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1 - INTRODUCTION

The inelastic process whereby a multicharged ion captures an electron from a neutral atom is important in environments containing both highly charged ions and neutrals. Cross sections for this electron-capture process at low energies are typically large ($>10^{-15}$ cm^2) and selectively populate excited states of the multiply charged ion. Such collisions, therefore, are important for plasmas of thermonuclear fusion, astrophysics, multicharged ion sources, and the development of X-ray lasers.

Only very limited data are available for electron capture by multicharged ions colliding with neutrals in the velocity range ($v<0.1$ a.u.). In such low-velocity collisions, the relative nuclear motion between collision partners is slow compared to the orbital motion of the active electrons of the system. Electrons of the temporary quasi-molecule formed in the collision have sufficient time to adjust to the changing interatomic field as the nuclei approach and separate. Coupled-state