Mutual Neutralization Studies of S^-/O^- and Na^+/Ne^+ at Low Collision Energies

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Anions play important roles in the chemistry of various astrophysical environments ranging from planetary and stellar atmospheres to interstellar clouds [1,2]. A key reaction for the ionization balance in those media is the Mutual Neutralization (MN) of atomic or molecular anions and cations [2]: $A^+ + B^- \rightarrow A + B$.

Cation and anions are accelerated to equal velocities in a merged beam setup, enabling measurements at collision energies as low as 5 meV. Three-dimensional momentum imaging is performed with two position sensitive detectors located 3.25 meters downstream from the 7 cm long region where the A^+ and B^- beams overlap. Besides providing clear coincidence signals between A and B products, this technique gives unambiguous identification of LS-terms of the products via the measurement of the Kinetic Energy Release (KER).

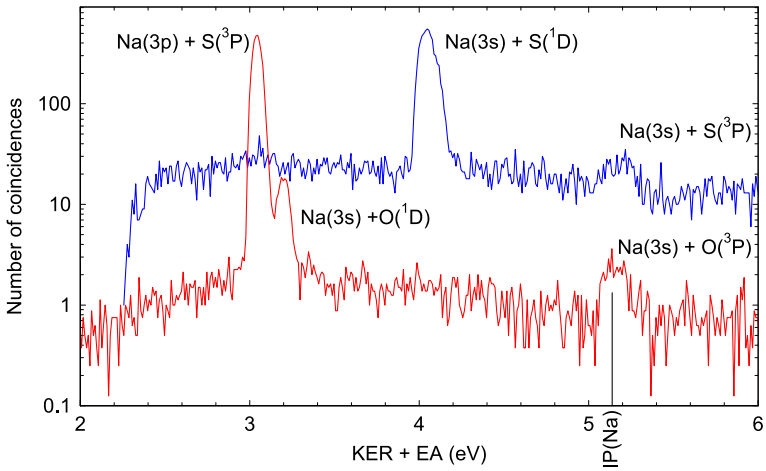

Figure 1: Experimental KER spectra shifted by the electron affinity (EA) of the anion. The blue curve shows the results for the $Na^+ + S^-$ reaction, the red curve shows the results for the $Na^+ + O^-$ reaction.

A previous study dealing with MN in collisions with O^- [3] has revealed the contribution of two-electron processes for N^+ as a cation. The population of core-excited configurations was qualitatively accounted for by including configuration mixing in the asymptotic treatment of electron transfer via the Firsov-Landau-Herring method [4]. We present here KER-spectra for Na^+ and Ne^+ colliding with O^- and S^-. While in all previous MN studies the neutralized cation was observed in an excited state, the present results demonstrate

electron capture to the ground state, leaving the electron donor in an excited state (Fig. 1). Such processes are beyond the applicability of the Firsov-Landau-Herring approach, calling for new theoretical developments.

References

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