K-shell Photoionization of the N^+, NH^+ and NH_2^+ ions

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Synopsis Single and double photoionization cross-sections in the photon region straddling the nitrogen K-edge and up to photon energies of ∼450 eV, for the atomic N^+ and molecular NH^+ and NH_2^+ species were measured at the SOLEIL radiation facility in Orsay, France. The measurements are compared with theoretical estimates.

Inner-shell photoionization of positive ions is a key process in various laboratory and astrophysical plasmas and interstellar clouds near star-forming regions. Ionized fragments created by the photoionization processes influence the dynamics and species abundance of these reactive gaseous media. Modelling of these processes, thus, requires the experimental knowledge of the absolute values of the photon cross-sections involved. Measurements are important to benchmark state-of-the-art theoretical calculations.

The MAIA photon-ion merged-beam apparatus at the SOLEIL synchrotron in France was used to measure single and double photoionization cross-sections in the photon region straddling the nitrogen K-edge and up to photon energies ∼450 eV, for the atomic N^+ and molecular NH^+ and NH_2^+ species. This extends prior work [1] on N^+ into the Rydberg region ($1s \rightarrow np$, $n > 2$ excitations), manifesting as sharp structures between 420 and 435 eV, up to and over the K-ionization threshold.

Photoionization of the NH^+ and NH_2^+ molecular ions were measured for the first time. The main fragmentation routes following $1s$ excitation in NH^+ and NH_2^+ produced mostly the N^{2+} species. The spectral patterns are similar to N^+: Strong discrete structures near 400 eV ($1s \rightarrow 2p$ excitations), followed by a Rydberg structure in the 410 - 430 eV regions. Significant broadening effects are apparent, testimony to the influence of the molecular vibrational degrees of freedom on the inner-shell photoionization process. The N^+ experimental spectra are compared with results of ab-initio RMPS and MCDF calculations, and the molecular spectra with the configuration-interaction single (CIS) method. Figure 1 illustrates our experimental and theoretical work for the atomic N^+ ion in the region of the K-edge.

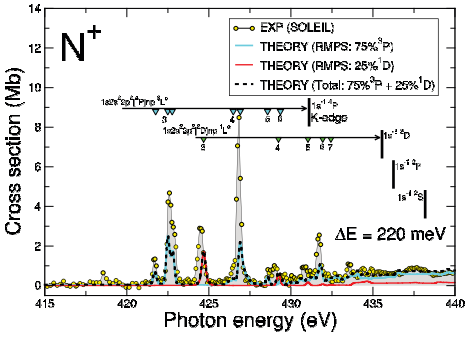

Figure 1. N^+ ions, theory and experiment, in the K-edge photon energy region.

References

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