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Dissociative recombination of NH^+

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Synopsis We have experimentally investigated dissociative recombination of NH^+ with electrons using a merged ion and electron beam configuration in a storage ring. A fast counting and position sensitive imaging detector enabled us to perform fragment imaging measurements over relative electron-ion collision energies from 0 to 12 eV. The results show unprecedented details on product excitation and on the reaction dynamics.

Dissociative recombination (DR) of molecular ions with electrons is one of the key processes in low density and low temperature plasma enviroments. DR removes ionized species and produces neutral fragments, thus affecting the chemical composition of the plasma. Rate coefficient, fragmentation branching ratios and excitation of final fragments resulting from DR give helpful information for modeling these plasmas.

Simple nitrogen hydrides, such as NH^+, are intermediates for forming ammonia in cold interstellar clouds [1]. Here DR is an important destruction channel for NH^+, thus reducing also the abundance of ammonia. Experimentally DR of NH^+ was previously studied only for vibrationally excited NH^+ [2].

We have experimentally investigated the DR of NH^+ at the TSR storage ring of the Max Planck Institute for Nuclear Physics in Heidelberg, Germany. A narrow, 6.2 MeV beam of vibrationally cold NH^+ was merged with a photocathode-produced electron beam. In this configuration we covered collision energies from sub-meV up to 12 eV. Utilizing an Energy-sensitive MUltistrip detector system (EMU) [3], we acquired projected fragment distance distributions for each collision energy. The fragment distances are proportional to the kinetic energy release (KER) in the reaction. In turn, the KER indicates the internal excitation of the DR products. We used a model to fit the fragment distance distribution [4]. In this way we assigned the product excitation channels and obtain their branching ratios at each collision energy. This information is important for understanding the DR dynamics in this multielectron system.

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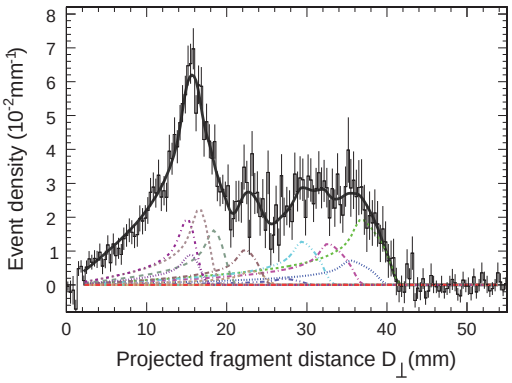

Figure 1. Normalized projected fragment distance distribution $P(D_\perp)$ measured in DR of NH^+ at a relative collision energy of E = 6.65 eV. The detector distance from the reaction zone was 9.41 m. The thin solid line displays the measured imaging data together with the statistical uncertainty. The thick solid line is the result of a fit with simulated distributions (dashed lines) corresponding to various product excitation channels.

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