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Electron-Ion Recombination at the Cryogenic Storage Ring

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The electrostatic Cryogenic Storage Ring (CSR) at the Max Planck Institute for Nuclear Physics in Heidelberg offers unique possibilities to study electron recombination of internally cold molecular ions as well as low-charged heavy atomic ions. The CSR provides a cryogenic environment with vacuum chamber temperatures < 10 K, resulting in a low residual gas density. This enables storage of ion beams for up to several thousand seconds, which in turn allows many molecular ion species to radiatively relax to their lowest electronic, vibrational, and rotational states in the weak blackbody radiation field of the CSR. In one section of the storage ring, a nearly mono-energetic electron beam is collinearly overlapped with the stored ion beam. This setup enables the investigation of electron-ion collisions at tunable center-of-mass collision energies ranging from several tens of eV down to the meV range. Due to the low ion beam energies of 300 keV per charge state, the merged electron beam has to be operated at low lab frame energies of only a few eV to reach the low collision energies. Here, recent electron-ion recombination experiments conducted at the CSR will be reviewed, including dissociative recombination of astrophysically relevant molecular ions and dielectronic recombination of low-charged heavy atomic ions. Special emphasis will be placed on electron collisions with fullerene ions, which exhibit significantly different reaction dynamics compared to small molecular ions. Additionally, recent advances in low-energy electron beam operation and electron cooling will be highlighted.

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