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Enhanced Recombination Rate in Ion Storage Rings: Formation of Rydberg Atoms during the Beam Merging[1]

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Electron-ion recombination plays an important role in many areas of physics, such as astrophysics, fusion plasma, and accelerator physics. With the aid of electron coolers in ion storage rings it has become possible to measure the recombination rate at very low energies (typically < 1 meV). For the experiments involving bare ions, the dominant recombination mechanism was attributed to radiative recombination. The measured rates[2] showed, however, a significant enhancement beyond the theoretical prediction[3]. We will discuss additional pathways for recombination due to the presence of guiding magnetic fields in the electron cooler. In the merging section a toroidal magnetic field guiding the electron beam crosses the ion beam with a finite angle and a transient motional electric field is induced in the rest frame of ion. This electric field forms Rydberg atoms and their radiative stabilization significantly contributes to the measured rate. The scaling of the rate with the ion charge and the magnetic guiding field is discussed. Understanding the origin of the observed enhancement is of importance for the analog process of antihydrogen formation presently studied in several experiments[4].

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