DIELECTRONIC RECOMBINATION IN He^+ IONS

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Dielectronic recombination (DR) was investigated for 1s$\rightarrow$ nln '1' transitions in He^+ + e-collisions.[1] DR occurs in an electron-ion collision when capture of the electron is accompanied by simultaneous ionic excitation, followed by subsequent radiative stabilization. The DR process is mediated by the electron-electron interaction, and proceeds through the inverse of an Auger transition; thus it is resonant for relative ion-electron velocities which correspond to exiting Auger-electron energies.

The ion storage ring and electron Cooler at IUCF were used in a "single pass" mode, i.e., the ions circled the ring, passed through the electron cooling region, were deflected by a ring magnet, and then collected in a Faraday cup. In the present case a beam of 44 MeV $^4He^+$ ions (current $\sim$ 100nA) was merged with the electron cooling beam (current $\sim$ 0.3A) over an interaction length of $\sim$ 2.8m. Events resulting in DR were detected by observing neutral He atoms produced in the electron Cooler. These atoms, which exited through a 0° port at the first dipole magnet following the cooler region, were observed with solid-state detectors in an E, ΔE arrangement, thereby allowing particle identification to separate the He atoms from background events.

For He^+(1s) ions DR is expected to occur for relative energies of 33-39 eV between the ion and electron. By ramping the relative electron energy from $|E_{rel}|$ = 0-50 eV, DR

could be investigated for electron velocities less and greater than the ion beam velocity. For $E_{rel} = 0$, a peak due to radiative recombination (RR) (inverse photoelectric effect) is expected.

In previous work[2] at IUCF, a hardware problem resulted in a large energy shift in the positions of the DR and RR maxima as well as poor electron energy resolution (~20 eV in the ion rest frame), thereby preventing a determination of which n states are dominant in the DR process. In the present measurements, the absolute electron energy was determined accurately and the resolution was improved considerably (~ 1.5 eV in the ion frame). A typical spectrum is shown in Fig. 1, in which DR maxima are observed for electron velocities smaller ($v_e < v_i$) and greater ($v_e > v_i$) than the ion velocity and the RR maximum for $E_{rel} = 0$ is also seen. The positions and widths of the DR maxima indicate that most of the dielectronic recombination occurs into states with $n \geq 3$ in agreement with theoretical predictions.

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1. J. A. Tanis, *et al.*, Nucl. Instrum. Meth. Phys. Res. **B43**, 290 (1989).
2. J. A. Tanis, *et al.*, Nucl. Instrum. Meth. Phys. Res. (1991), in press.
3. M. S. Pindzola, N. R. Badnell, and D. C. Griffin, Phys. Rev. **A42**, 282 (1990).

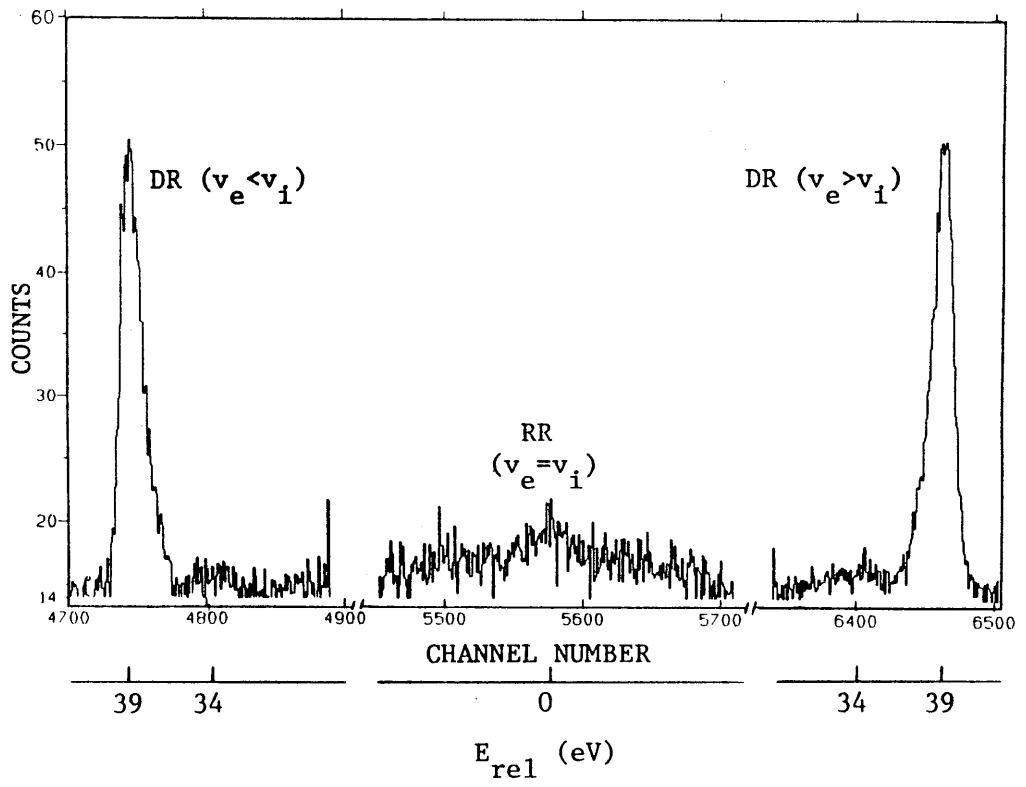

Figure 1. Intensity of neutral He atoms formed in the Cooler region as a function of electron energy.