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Experimental Resolution Reached in Recombination Measurements at the Electron Cooler of the Storage Ring ESR

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Dielectronic recombination (DR) and radiative recombination (RR) processes in collisions of the 107.1 MeV/u U^{89+} ions with free electrons have been studied in the electron cooler of the ESR storage ring at GSI. Relative velocity between electrons and ions was varied by applying a sequence of predefined potentials to the drift tubes in the cooler. Typically measuring time for each potential was 30 ms with 20 ms a dipole magnet down-stream from the cooler and a second detector placed on the opposite side of the ring monitored background events. Details of the experiment are described in [1].

From the DR spectra one can obtain precise knowledge of the resonance energies of doubly excited states and information on the collision dynamics, transition matrix elements and branching ratios in the capture and de-excitation processes. The measurement of resonance line-shapes additionally provides information on the velocity distribution of the cooler electron beam and/or the natural widths of the resonance states.

The detailed analysis of the data is underway. Some parts of recombination rate spectra are shown in Fig. 1 and 2, and are compared with theoretical predictions by Zimmermann et al. [2]. The sharpness of the RR peak at $E_{cm} = 0$ demonstrates an excellently low electron beam transverse temperature and its very good cooling efficiency. As can be seen in Fig. 2, the energy resolution (energy spread of the ion and electron beams) is better or at least comparable with the natural linewidths of the DR resonances. Therefore, one can investigate the validity of different approximations in DR theory by studying effects determining the lineshape, e.g. overlapping resonances or interference effects.

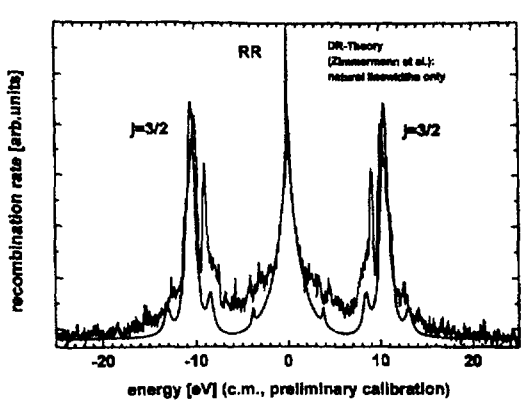

Fig. 1: Dielectronic and radiative recombination of Li-like U^{89+}. Preliminary experimental data and calculations of the $U^{88+}(1s^2 2p_{3/2} 5l_{3/2})$ resonance group. Background is not subtracted. "Negative" energies indicate that electrons are slower than ions in the laboratory frame.

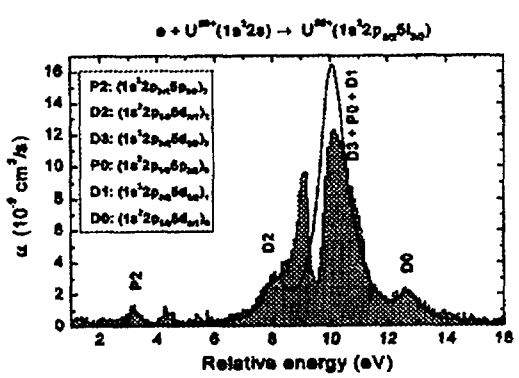

Fig. 2: Experimental data (shaded area) and theoretical calculations [3] (solid line) for the U^{88+} $(1s^2 2p_{3/2} 5l_{3/2})$ DR-resonance group. The RR contribution and the background have been subtracted. Calculated resonance lines are convoluted with the natural linewidths and Maxwellian velocity distribution corresponding to the cooler cathode temperature.

References:

1. C. Brandau et al., Hyperfine Interaction **114** (1998) 263 and Physica Scripta T (1999) (in print);
2. M. Zimmermann, N. Grün, and W. Scheid, *private communication;*
3. T. Steih, W. Scheid, and N. Grün, *private communication.*