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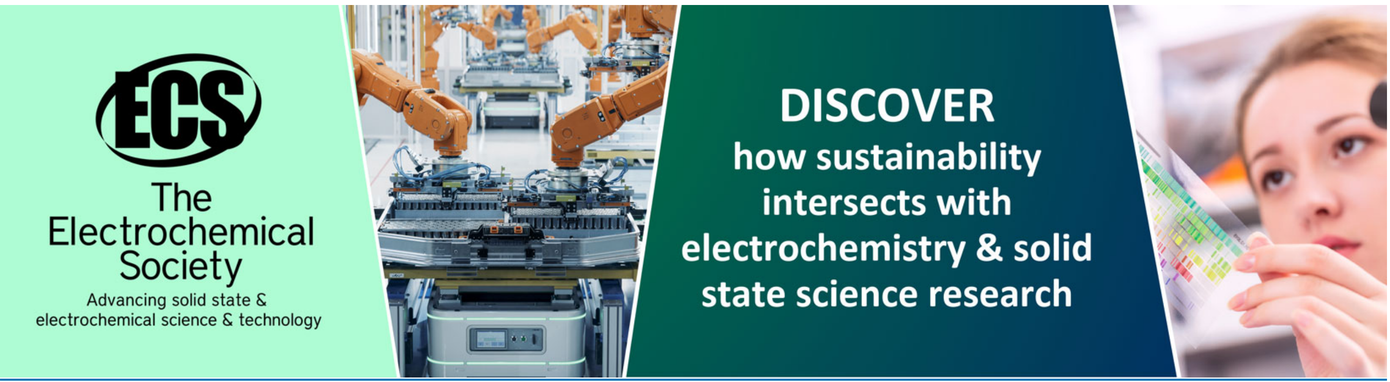

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Dielectronic recombination of hydrogen-like krypton

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Synopsis The KLL dielectronic recombination (DR) of hydrogen-like krypton has been studied with the Tokyo electron beam ion trap. The resonant strengths have been determined by normalizing the DR X-ray intensity to the $n = 1$ radiative recombination X-ray intensity. The experimental result is compared with multi-configuration Dirac-Fock calculations.

Dielectronic recombination (DR) is a two-step process composed of resonant electron capture which results in a doubly excited state and radiative decay of the doubly excited state. DR is one of the most important processes in hot plasmas, because it strongly affects the ionization balance and the X-ray radiation of plasmas [1]. In the DR process into a hydrogen-like ion, a K-shell vacancy is still left after the primary X-ray decay of the doubly excited state. Thus, the singly excited state also decay with emitting another K X-ray, whose energy is slightly different from that of the primary [2, 3]:

$$\begin{aligned} \mathrm{e}+\mathrm{A}^{q+}(1s) &\rightarrow \mathrm{A}^{(q-1)+**}(2l2l') \\ &\rightarrow \mathrm{A}^{(q-1)+*}(1s2l') + h\nu_1 \\ &\rightarrow \mathrm{A}^{(q-1)+}(1s^2) + h\nu_2 + h\nu_1. \end{aligned}$$

An electron beam ion trap (EBIT) is a useful device for studying such DR processes of highly charged ions. It can trap highly charged ions interacting with a quasi-monoenergetic electron beam. In the study of DR, X-rays emitted from the trapped ions are observed as a function of electron beam energy. The contribution of the second K X-ray should thus be considered for the DR observation for hydrogen-like ions.

In this paper, we present DR measurement for hydrogen-like Kr performed with the Tokyo-EBIT [4]. To obtain the high abundance of hydrogen-like ions, the electron beam energy was fixed at 28 keV for 2 s. After this "cooking" time, the electron energy was scanned between 8 keV and 10 keV, which covered the KLL DR resonances. This "probing" time was about 10 ms, and then, the energy was switched back to the cooking energy and kept for 90 ms to preserve the H-like ion abundance. X-rays emitted from the trapped ions were observed with a Ge detector.

The pulse height (corresponding to the X-ray energy) of each signal was recorded with the beam energy at the time when the photon was detected. The DR cross section was then obtained by normalizing the DR X-ray intensity to the $n = 1$ radiative recombination X-ray intensity. The result of preliminary analysis is shown in Fig.1 together with the multi-configuration Dirac-Fock calculation. In the present calculation, the contribution from the second K X-ray from 1s2s $^1S_0$ is omitted because the branching ratio of two-photon decay is almost the unity for this state.

We present the comparison with a detailed calculation with the contribution of the branching ratio of the other singly excited states and the polarization. Comparison between the experimental and the theoretical DR X-ray spectra is also presented.

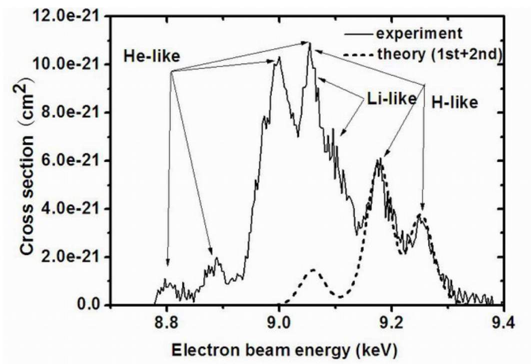

Figure 1. Comparison of the cross section between the experiment and theoretical calculation (preliminary).

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