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Higher-order recombination processes in Argon ions observed via x-ray emission in an EBIT

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The electron-electron interaction is a crucial aspect of atomic reactions involving electron-ion collisions. An effective way to investigate electron-electron interaction is to study the higher-order recombination processes. The most basic of those recombination processes is dielectronic recombination. DR is the time reversal to the Auger process and thus is well-known and investigated in many different highly-charged systems [1,2]. In this resonant process, a free electron is captured while another bound electron is excited due to the direct interaction between the two electrons. The recombination is completed through radiative stabilization of the excited ion. The research presented here was conducted the Jagiellonian University EBIT [3]. An XFlash SD x-ray detector was positioned perpendicular to the electron beam axis. The very good resolution of the x-ray detector enabled the K-LL DR resonances to be distinguished for He- up to N-like Ar ions. In this region, in addition to the K-LL DR, one of the $2p_{1/2}$ subshell electrons can be excited to the $2p_{3/2}$ subshell state [2]. A significant influence of various intershell TR processes (KL-LLL) was observed and caused a broadening of Be- to N-like DR lines presented in Figure 1 [2]. These results encouraged more detailed present studies of TR, specifically of KK TR. There, the resonant capture of a free electron to an ion-bound state transfers two K-shell electrons to a higher atomic shell. This way, a doubly-excited K-shell state is produced and, in most cases, it decays via emission of two photons. The first transition with two vacancies in the K shell is responsible for the emission of photon (K^h) with a slightly higher energy than following satellite transition (K^s). This TR process has been not reported yet to the best of our knowledge. This work presents significant arguments for a successful observation of the KK-LMM TR process in Ar ions. The data set was collected for the trap ionization time between 100 ms and 250 ms for different electron-beam energies in the region (5200-7500) eV. This electron energy region was expected to manifest a significant enhancement of the hypersatellite Ar-K x-ray emission due to the TR processes mentioned above. Indeed, we observed a maximum-like behavior of the intensity ratio between this radiation and the satellite Ar-Kα radiation presented in Figure 2.

Figure 1:

References:
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