Radiative double electron capture (RDEC) in F^{9+} + N_2 collisions

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Synopsis. The latest results obtained for radiative double electron capture (RDEC) by 40 MeV fully-stripped fluorine ions in collisions with nitrogen are presented. A preliminary cross section for RDEC based on the measurement gives the value 120 mb, which is consistent with the previous experimental values.

Radiative electron capture (REC), in which one electron is captured to a bound state of a projectile ion from a target atom by emitting a single photon in ion-atom collisions, can be considered as the time reversed process of photoionization. Radiative double electron capture (RDEC) occurs when two target electrons are captured to bound states of a projectile ion accompanied by the emission of a single photon in a single step process. RDEC has a much smaller cross section compared to REC, but is important in studying the correlation of electrons.

Three experiments [1,2,3] at GSI, Darmstadt and two experiments [4,5] at Western Michigan University attempted to show evidence for RDEC using different projectile-target systems. The first positive results [4] were observed for 38 MeV O^{8+} on thin carbon foils.

Here we present the latest results for RDEC from 40 MeV F^{9+} colliding with N_2 (pressure ~8 mTorr) done at the WMU accelerator facility. Coincidence techniques were used to observe the x rays corresponding to single and double capture. Results are shown in Figure 1 for double capture with the background subtracted.

Expected REC and RDEC photon energies for the projectile-target system were calculated considering the energy corresponding to different electron binding energies in the initial and final states plus the electron kinetic energy of the electrons relative to the projectile. Calculated positions of REC and RDEC peaks, corresponding to different transitions of the electrons from target to projectile, are shown in Figure 1. In general, the photon events observed spread around these central values due to the momentum distribution (Compton profile) of the electrons in the target.

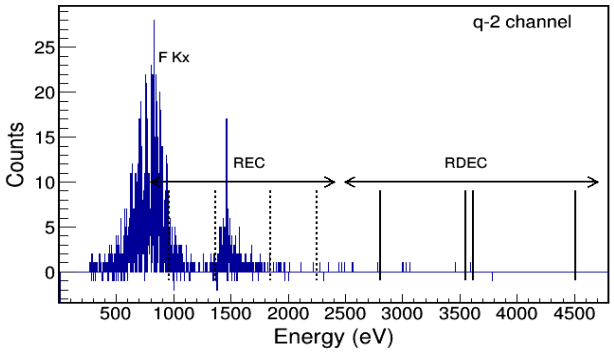

Figure 1. X rays coincident with double capture for 40 MeV F^{9+} + N_2. Calculated line positions for REC (due to K→L, valence→L, K→K, and valence→K transitions, respectively) are shown as broken vertical lines and for RDEC (due to KK→KL, KK→KK, valence-valence→KL and valence-valence→KK transitions, respectively) as solid vertical lines.

The spectrum shows about ten RDEC counts with most concentrated in the lower part of the RDEC energy range, consistent with the spectra of [4,5]. Based on these events the cross section for RDEC was calculated to be 120 mb, in reasonable agreement with recent theoretical calculations of Mistonova and Andreev [6]. New measurements are planned to take more data for the gas target N_2 for which it is estimated that two months of continuous beam time will be needed. This project is funded by the NSF under Grant No. PHY-1401429.

References

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