5.7. Internal and external double-electron ejection

K. PISK and K. ILAKOVAC, *Institute »Ruđer Bošković«, Zagreb*

Processes of double electron ejection from an atom due to the absorption of a real or virtual photon have been considered. The amplitudes of the processes consist mainly of two coherent parts: the »shake-off« and the »direct collision« amplitude[1]. In the absorption of a virtual photon (e. g. decay of a nuclear excited state) a second order transition[2] is also possible, but the contribution of this process is usually negligible[3]. The shake-off and the direct collision amplitude were calculated by Feinberg[4] for the internal ionization in beta decay. Porter et al.[5] applied those results for an estimate of internal ionization in K-conversion.

In this paper our calculations of the direct collision amplitudes of the internal and external double electron ejection are discussed. The impulse approximation[6] was applied, i. e. the nuclear Coulomb field was taken into account only through the wave functions of bound electrons. Feynman diagram techniques were used to calculate the amplitudes of transitions.

In the case of absorption of a real photon (double-electron photoelectric effect), the differential cross sections $d\sigma/d\Omega_1 d\Omega_2 dT$ were calculated. Since three particles are in the final state, the directions of emission $d\Omega_1$ and $d\Omega_2$ of the electrons are independent and the energy of one electron T is continuously distributed. A helium-like atom of nuclear charge Ze was assumed and the mutual perturbation of the two electrons neglected (before the absorption of the photon). The calculated energy distributions of electrons are generally double peaked. The cross sections integrated over the energy increase with increasing Z and decresing energy of incident photons, and show a strong dependence on linear polarization (the scattering is mainly in the plane of polarization).

A multipole expansion of the interaction between K electrons and the nucleus was made in the calculations of the direct collision process in internal ionization in K conversion. Coulomb interaction in the electron-electron collision was assumed. Only magnetic type transitions of the nucleus were considered. For the double — K electron ejection process the differential probabilities $dw(\Theta)/d\Omega dT$ were calculated, where Θ is the angle of relative emission of the electrons and T the energy of an electron. The same approximations were applied in the calculations of the K conversion for the same nucleus, energy of transition and multipolarity. The ratio of probabilities for the KK process integrated over the energy or over the solid angle and of the K-conversion transition probabilities was calculated for comparison with experimental measurements.

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