Kinetics of Atomic Cascade in Muonic and Hadronic Hydrogen Atoms

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The evolution of the kinetic energy of exotic hydrogen atoms during their atomic cascade is very important to analyze the precision spectroscopy experimental data [1]. In particular, the kinetic motion of the exotic atoms at the instance of the radiative transitions results in the Doppler broadening of the measured X-ray lines and can be, in principal, predicted by ab initio cascade model calculations.

In this report we present a preliminary results of the calculations which are obtained with a new version of the extended standard cascade model [2]. In the present cascade model, for the first time, the differential and total cross sections of the collisional processes (elastic scattering, Stark transitions and Coulomb deexcitation) calculated in unified manner in framework of the close-coupling approach [3, 4, 5] are included in the atomic cascade for all $nl \to n'l'$ transitions with $n = 2-8$ at relative energies $E = 0.01-250$ eV. The yields of K X-rays and the distributions of $\mu^- p$ and $\pi^- p$ atoms in the nl-states over kinetic energy at the moment of the radiative transition were calculated. The kinetic energy distribution of the $\pi^- p$ atom at the instance of nuclear absorption in liquid hydrogen target are also calculated. The obtained results are in good agreement with the experimental data.

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[1] D. Gotta, Prog. Part. Nucl. Phys. **52**, 133 (2004).
[2] T.S. Jensen and V.E. Markushin, Eur. Phys. **D 21**, 271 (2002).
[3] G.Ya. Korenman, V.N. Pomerantsev and V.P. Popov, JETP Lett. **81**, 543 (2005).
[4] V.N. Pomerantsev and V.P. Popov, JETP Lett. **83**, 331 (2006).
[5] V.N. Pomerantsev and V.P. Popov, Phys. Rev. A **73**, 040501(R) (2006).