Electron-loss-to-continuum cusp in relativistic collisions of uranium ions with gaseous targets

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Synopsis An approach to calculation of differential cross sections for ionization in ion-atom collisions is extended to describe electron loss to continuum in collisions of partially stripped uranium projectiles with neutral targets. The results for energy distribution of the electrons ejected in the 90 MeV/u U^{88+}-N_2 collision are presented and compared with experimental data and previous theoretical predictions. The relativistic and retardation effects are studied.

Collisions of highly charged ions with atoms and molecules represent a unique tool for investigating the electron dynamics and testing various theoretical approaches. With the implementation of storage rings, the process of electron loss to continuum (ELC) became accessible for experimental study. In this process, the projectile (heavy ion) is ionized in a collision with a gas target. Due to kinematical conditions the electron emission in the laboratory frame occurs mainly in a narrow cone around the ion direction of motion with a velocity close to the ion velocity. Herewith in the energy distribution of the emitted electrons a specific cusp at the energy corresponding to zero emission energy in the projectile reference frame is observed. Although for some systems this process has been investigated since a long time theoretically [1, 2], as well as experimentally [3], its detailed experimental study was hampered by the need to use the coincidence technique. Along with the detection of the emitted electron, it is necessary to detect the change of charge state of the projectile after the collision. This allows one to distinguish between electrons ionized from the projectile and target. Thus, the first experiments exploiting the coincidence technique to measure the spectrum of electrons emitted by heavy ions in collisions with gas targets were carried out only quite recently [4, 5]. The theoretical description of these experiments was performed within the framework of first-order perturbation methods. For the 90 MeV/u U^{88+}-N_2 collision the theoretical results are in good agreement with the experimental data [4]. However, for the 50 MeV/u U^{28+}-H_2, 30 MeV/u U^{28+}-N_2 and 50 MeV/u U^{28+}-Xe collisions the agreement is quite poor: the experiment shows strong asymmetry of the cusp, while the theory predicts an almost symmetric cusp [5]. Possible reasons for this discrepancy are due to the use of a too simple model for the multielectron structure of the uranium ion and the use of first-order perturbation-theory methods.

In this contribution, we report a recent progress in extension of our relativistic approach to calculation cross sections for ionization in ion-atom collisions [6, 7] towards description of the aforementioned experiments.

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