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Single and multiple ionization of rare gases by H^0 impact

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Synopsis Cross sections for the multiple ionization of He, Ne, Ar, Kr by H^0 impact with and without the simultaneous ionization (electron loss) of the projectile have been measured in the energy range 75 – 300 keV. Information about the role played by the electron of H^0 in the collision was obtained by repeating the measurements with protons under the same experimental conditions.

The understanding of the mechanisms of collisions between energetic charged particles and neutral atoms is of fundamental significance.

In the present work we measured total direct ionization and electron loss cross sections for the collisions of H^0 atoms with noble gas atoms (He, Ne, Ar, Kr) in the energy range 75-300 keV. The experiment was carried out at the 1.5 MV Van de Graaff accelerator of Atomki by coincident detection of the recoil target ions and the charge-state analyzed scattered projectiles. With this study we wished to obtain information about the role played by the electron of the H^0 projectile in the process of the single and multiple vacancy production induced by the collision. For this purpose we repeated the measurements also with proton projectile under the same experimental conditions. For calibration of the measuring system and normalization of our data we used the cross section values of Ref. [**?**]. The experimental results were analysed with using the classical trajectory Monte Carlo (CTMC) method. CTMC describes well the experimental data for both projectiles for the single vacancy creation, however we observed increasing deviation between the theory and experiment with increasing number of the created vacancies, as well as with decreasing atomic number of the target atoms.

Fig. 1 shows our results obtained for the single, double and triple ionization ($q = 1, 2, 3$) of Kr at H^0 impact for the two cases when the outgoing projectile is H^0 (a) and H^+ (b), i.e., for pure ionization of the target, and ionization of the target with simultaneous electron loss of the projectile. The curves in the figure were obtained by two versions of the three-body CTMC theory: a conventional model [**?**] [**?**] (dashed curves); and a model taking partially account of the many-body character of the collision (a simplified version of the nCTMC theory [**?**], solid curves).

Further theoretical calculations in the framework of the Continuum Distorted Wave (CDW) theory are in progress.

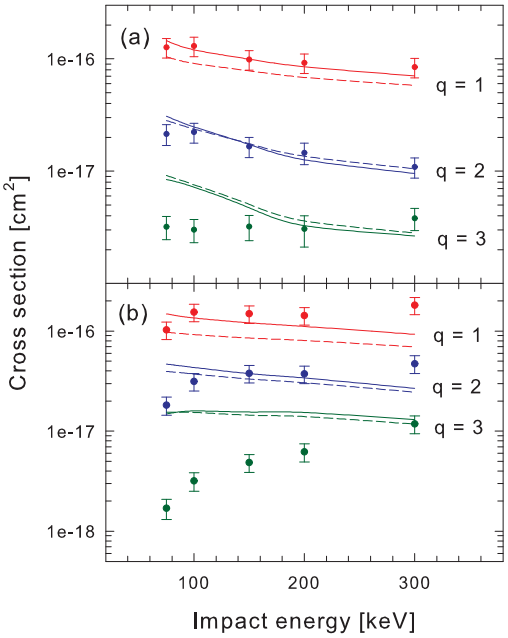

Figure 1. Cross sections for ionization of Kr by H^0 impact as a function of the collision energy. The full circles with errors bars are the measured data obtained for H^0 (a) and H^+ (b) outgoing projectiles. q is the charge state of the recoil target ions. The curves are results of CTMC calculations (for explanation see text).

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