ATOMIC K-SHELL IONIZATION CROSS SECTIONS BY 1 GeV PROTONS

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The study of atomic inner shell ionization by accelerated charged particles with masses greater than an electron one was carried out mainly for projectile energies less than a few dozens MeV/amu [1]. The main purpose of this work is to obtain a new experimental data for atomic K-shell ionization cross sections to test a theoretical description of ionization at the projectile energy over 100 MeV/amu.

The measurements were performed with $Si(Li)$ and $Ge(Li)$ spectrometers by detection of the characteristic X-rays from a target irradiated by 1 GeV protons of PNPI synchrocyclotron [2]. Thin foil targets were irradiated in a vacuum chamber. Lead protected detectors were placed at 135 degrees to the proton beam line. The experimental data were corrected to take into account the contribution of X-rays, caused by secondary particles in the target. The correction was obtained using the nonlinear dependence of total X-ray yield on the target thickness. The calculations of ionization cross sections have been performed in the plane wave Born approximation accounting for current-current interaction between projectile and atomic electron and spin-flip effect caused by the change of the spin of the atomic electron while being ionized [3, 4]. The hydrogen-like semirelativistic wave function was used to describe the K-electron.

Fig. shows comparison of experimental cross section with calculated one. It should be noted that the quite satisfactory agreement between experimental data and theoretical calculations has been obtained besides the results for high-Z targets. The reason for discrepancy can be due to the effect of relativity of K-shell electron for heavy elements.

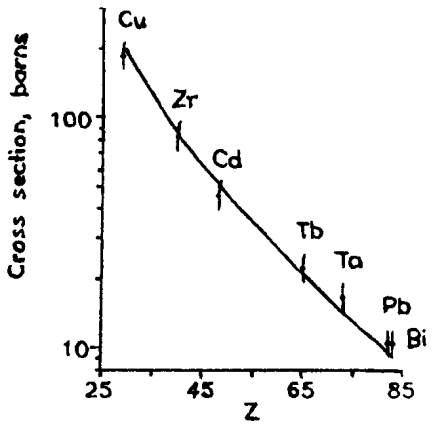

Fig. Atomic K-shell ionization cross sections by 1 GeV protons versus target atomic number. Points — experiment, curve — calculation

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