

Double K-shell ionization of Kr induced by swift Xe⁵⁴⁺ ions

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Zhangyong Song^{*}, Rongchun Lu^{*}, Junliang Liu^{*}, Yipan Guo^{*,§}, and Xiaohong Cai^{*,2}

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Synopsis K α satellite and hypersatellite lines of Kr induced by 52-, 94-, 146-, and 197-MeV/u Xe⁵⁴⁺ ions were measured. Experimental values were compared with theoretical ones obtained within the independent electron model (IEM) employing single electron probabilities calculated with the semi-classical approach (SCA). This comparison suggests that first order perturbation approximation is consistent well with the experimental result at 197-MeV/u projectile collision while breaks down for the lower energies.

Double K-shell ionization of atoms by collisions with charged ions is one of typical two-electron processes and attracts considerable attention both in term of basic theory and experiment. Radiative de-excitation of the double K-shell vacancy states of atoms leads to the emission of so called K x-ray hyper-satellites (K α^h , K β^h ...) [1], which gives us the insight into the decay modes of multiply ionized ions as well as the ionization processes during ion-atom collisions. Contrary to the long-winded and difficult experiments with heavy target due to the low detection efficiency of K x-ray hyper-satellites with crystal spectrometers [2-4], the bulk of knowledge concerning double K-shell ionization in ion-atom collisions has been obtained for light target.

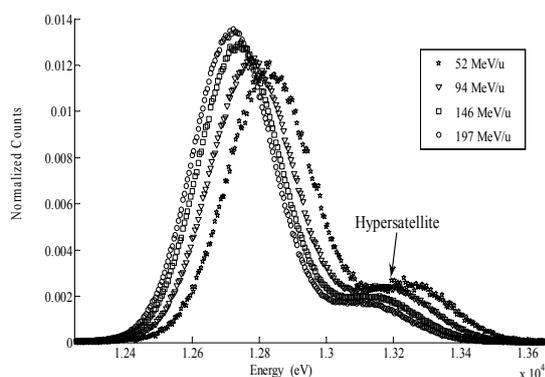


Figure 1. K α X-ray spectra of Kr atom induced by 52-197 MeV/u Xe⁵⁴⁺

In this work we report on the double- to single-K-shell ionization ratios of Kr by collisions with 52-, 94-, 146-, and 197-MeV/u Xe⁵⁴⁺ ions. Taking advantage of the storage ring and its internal target facility where secondary effects could be negligible and charge state could keep single, the double- to

single-K-shell ionization ratios for the four collisions were investigated by detecting corresponding K α line. The measured K α X-ray energy spectra of Kr obtained at 90° observe angle with a Si (Li) detector are presented in Fig.1. The K α X-ray hypersatellites were resolved by Si (Li) detector with energy resolution of 250 eV at 12.6 keV. The peaks position and counts of hyper-satellite could be extracted by double Gaussian function fitting.

Experimental values were compared with theoretical ones obtained within the independent electron model (IEM) [5] employing single electron probabilities calculated with the semi-classical approach (SCA) [6]. This comparison suggests that first order perturbation approximation is consistent well with the experimental result at 197 MeV/u projectile collision while breaks down for the lower energies.

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