Electron capture and subsequent radiative decay of fast Xe^{54+} ions in collisions with Kr and Xe gaseous targets

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Synopsis The process of electron capture is studied for initially bare xenon ions colliding with krypton and xenon gaseous targets at incident energies of 52-197 MeV/u. The alignment of the L-shell magnetic sublevels has been obtained via angular distribution of the $Ly_{\alpha 1}$ photons from hydrogenlike ions of xenon.

Non-radiative capture (NRC) and radiative electron capture (REC) are two competing mechanisms in collisions between energetic highly charged ions and atoms. NRC means electron transfer from a bound state of the target to a bound states of the projectile without the emission of radiation; REC is produced with simultaneous the emission of photon for satisfying energy and momentum conservation laws. The physical essence is the competition between the "electron-nucleus" interaction and the "electron-vacuum" interaction. NRC is dominant in collisions of high-Z ions with heavy target atoms at moderate energies. REC entirely determine the electron capture channel for high collision velocities and light targets. Measuring the projectile x-ray emission associated with electron capture could determine state-selective and angular differential cross sections, as well as provide a detailed test of the theory of atomic reaction dynamics [1, 2].

Projectile x-ray spectra were recorded in collisions of 52, 94, 146, and 197 MeV/u bare Xe ions with Kr and Xe gaseous targets, at different observation angles 35°, 60°, 90°, 120°, and 145°. The experiments were performed at the heavy-ion cooling storage ring HIRFL-CSRe [3] at Lanzhou. The internal jet target [4] was used at area density of 10^{12} atom/cm^2. The vacuum in the CSRe was better than 10^{-12} mbar. The continuously active electron cooler compensated the beam loss caused by the interaction of the ions with the gaseous target. Therefore, the experiment was single-collision, large luminance and ultra-low background.

After Doppler correction and detection efficiency correction, the x-ray spectrum in the emitter system for 146 MeV/u Xe^{54+} ions collision with Kr and Xe as observed by the germanium detector at 35° is given in figure 1, the main transitions for H-like and He-like Xe ions are also displayed. The analysis of x-ray spectra is based on Gaussian-Amplitude function peak fitting procedure and determination of the characteristic transition intensities. The value of anisotropy parameter β_{20} could be extracted by the experimental angular distribution of the $Ly_{\alpha 1}/Ly_{\alpha 2}$ intensity ratio. Also, the population of the excited states for H- and He- like xenon ions can be derived from β_{20} combined with the transition rates for the cascade decay of the excited states calculated by GRASP code [5].

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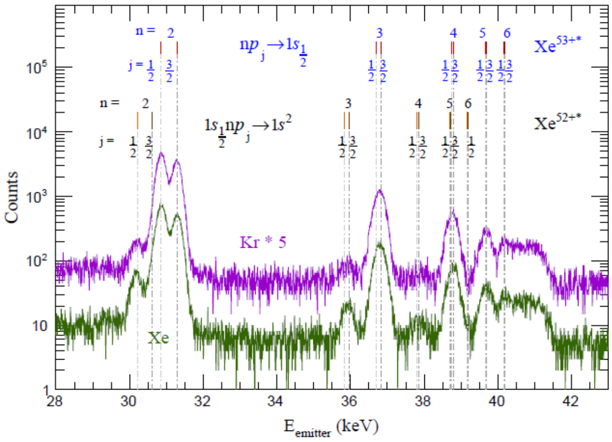

Figure 1. The x-ray spectrum for excited states of H- and He- like Xe ions associated with electron capture into the 146 MeV/u Xe^{54+} ions colliding with Kr and Xe, as observed at 35° in the emitter frame. The counts of Kr data was multiplied by a factor of 5 for better display.

References

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