2 - 6 L-L Vacancy Sharing in near-symmetric Heavy Ion-atom Collision

Ren Jieru, Zhao Yongtao, Zhou Xianming, Cheng Rui, Lei yu, Sun Yuanbo, Wang Yuyu
Wang Xing, Xu Ge, Li Yongfeng, Yu Yang and Xiao Guoqing

A search of literature shows that measurements of L X-ray line structure and production cross section in near-symmetric collisions with projectiles as heavy as Kr ions are pretty limited. A large amount of investigations have revealed that the in near-symmetric collisions, the Coulomb theory usually badly agrees with the experimental result, neither in terms of the absolute cross section value nor the target atomic number dependence of the cross section[1,2]. The quasi-molecular theory based on electron promotion model provides a totally new and useful view to understand these unexpected phenomena.

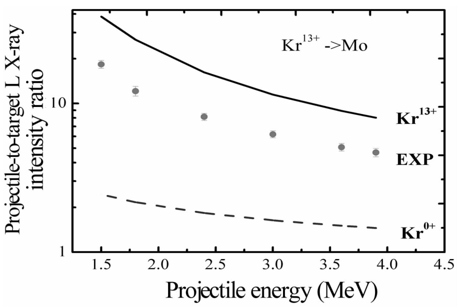

Fig. 1 Comparison of the experimental result for projectile-to-target L X-ray intensity ratio in Kr^{13+}->Mo collision with the prediction of vacancy sharing theory. The theoretical result for Kr^{13+} is represented by solid line and Kr^{0+} by dashed line. The experimental value is presented by dot with an error bar of about 5%.

For L-vacancy production, in near-symmetric collisions, this model assume that the vacancies are brought into the L shell of lower-Z collision partners via 4fσ molecular orbit (MO) promotion in the ingoing part, and on the outgoing part, the vacancies are shared by L shell of the higher-Z collision partner with a certain probability[2]. The sharing probability involves the energy gap between L shells of the collision partners.

The projectile-to-target L X-ray intensity ratio as a function of incident energy for Kr^{13+} impacting on Mo target is compared with the predictions of the vacancy sharing model in Fig. 1. The theoretical results for projectile charge states of both 0+ and 13+ are presented.

Actually, as the projectiles penetrate into the solid target, they will reach equilibrium charge state of about 6+ after a length of hundreds of atomic layers. Later along the trajectory, the equilibrium charge state will decrease gradually until zero. Therefore, the experimental results should be understood as an average over the charge states between 0+ and 13+. This reasonably explains why the experimental ratio shows a similar trend to the cases for Kr^{0+} and Kr^{13+} as a function of projectile energy, while the absolute value lies between these two theoretical lines.

References

[1] R. L. Watson, Y. Peng, V. Horvat, et al., Phys. Rev., A74(2006)062709.
[2] W. E. Meyerhof, A. Ruetschi, Ch. Stoller, et al., Phys. Rev., A20(1979)154.