3 - 14 Rearrangement in $K\alpha$ Hypersatellite Spectra of Argon Induced by Energetic Heavy Ions

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The production of double K-shell vacancies in collisions by energetic heavy ions is usually accompanied by the creation of higher-order multiple vacancies in atom[1]. The vacancy configurations, which reflect information of the collision dynamics, may be obtained from measurements of the associated K X-ray hypersatellite spectra. Because of some L-shell vacancies being filled from higher shells complete prior to decay of the K vacancy, vacancy configurations created in collision may differ substantially from that exist at the time of K X-ray emission[2]. In order to evaluate this rearrangement effect, a Monte Carlo program was developed to simulate $K\alpha$ hypersatellite spectra of argon induced by heavy ion.

The analysis begins with the assumption that the initial population distribution of vacancy in each shell were binomial, characterized by the average vacancy number in L-shell n_L^0 and M-shell n_M^0, respectively. n_L^0 and M-shell n_M^0were related according to the universal scaling formula of the geometrical model[3,4]. The initial vacancy number of L-shell and M-shell were generated by sampling from the corresponding distribution functions, respectively. The distributions of both L- and M-vacancies over the subshells were assumed to be statistical. Since the maximum number of vacancy in K, L_1, L_2, L_3, M_1, M_2 and M_3 shell is equal to 2, 2, 2, 4, 2, 2 and 4, respectively, a total of 6 075 vacancy configurations were considered. After initial vacancy configuration was sampled, the transition rates of all possible decay channels were calculated by using a statistical weighting procedure where the original various radiative and radiationless transition rates of a single vacancy argon are obtained from tabulated data[5,6]. Then one of the decay channel was chose by sampling of relative probabilities of all possible transitions. After the occurrence of the chosen transition, a new configuration of vacancies created. The consideration of this configuration was similar to that at the prior step. The rearrangement process was followed until no further decays are possible in the filling of the K vacancy. After finishing with one cascade process, initial vacancy configuration was again sampled and the cascading was again simulated. After multiple simulations (10^6 atoms per n_L^0) the final emitted $K\alpha$ spectra were obtained by the statistical analysis.

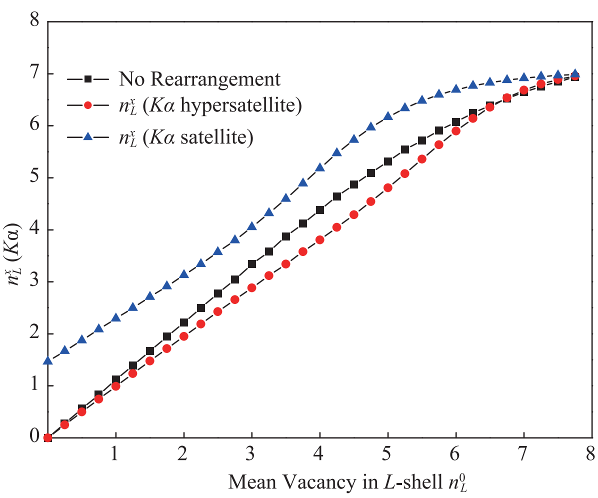

Fig. 1 (color online) Simulated relation between n_L^0 and n_L^x for $K\alpha$ transitions.

The simulation results were shown in Fig.1. The abscissa represents the original average number in L-shell n_L^0, and the ordinate represents that at the time of K X rays emission n_L^x. As can be seen clearly from the Fig.1 that the difference n_L^x of considering the rearrangement effect and without considering the rearrangement effect were obvious. Since main filling channel of the first K-shell vacancy of the double K-shell vacancy states would increase the vacancy number in of the L-shell, the n_L^x at the time of $K\alpha$ satellites emission were much larger than that of $K\alpha$ hyper satellites. The present results may use to deducing the initial L-shell vacancy distribution in energetic heavy-ion-atom collisions from the $K\alpha$ hypersatelltie spectra.

References

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