Systematics of L x-ray Spectra Excited by Heavy Ion Collisions

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The previously reported target L x-ray study [1] has been extended to include Ne, Kr, and Xe projectiles at 10 MeV/u. Spectra for a variety of targets obtained with 6 MeV/u Kr projectiles are shown in Figure 1. These spectra are characterized by both narrow peaks (diagram lines) originating from singly ionized target atoms and broad (satellite) distributions originating from atoms with various degrees of multiple ionization.

The fitting function, described previously [2], consists of single Gaussians representing the diagram lines and groups of Gaussians representing the satellites. The individual Gaussians in each group are fixed at the energy calculated for each satellite transition represented [3] and constrained to follow a binomial intensity distribution This fitting function has been expanded to also include satellite contributions from $L\beta_3$ transitions in addition to the $L\alpha_1$ and $L\beta_1$ transitions previously reported.

The average number of L-shell vacancies extracted from fits of the $L\alpha_1$ satellites of spectra excited by 6 MeV/u Kr ion impact such as those shown in Figure 1 are presented in Figure 2 as a function of target atomic number. The gaseous Xe target result (Z_2=54) is shown as an open circle and, as discussed previously [4], is substantially lower than would be expected for a solid target of the same atomic number. This is

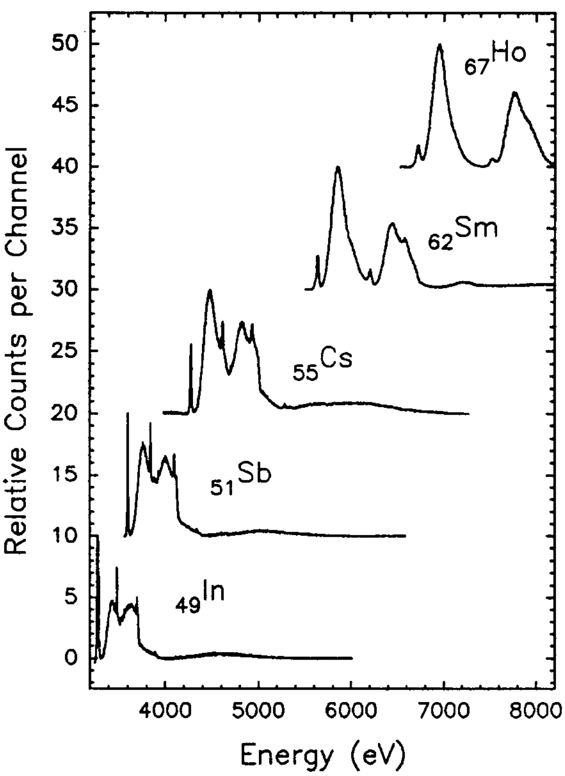

Figure 1. L x-ray spectra from selected targets ranging in atomic number from 49 to 67 excited by bombardment with 6 MeV/u Kr ions.

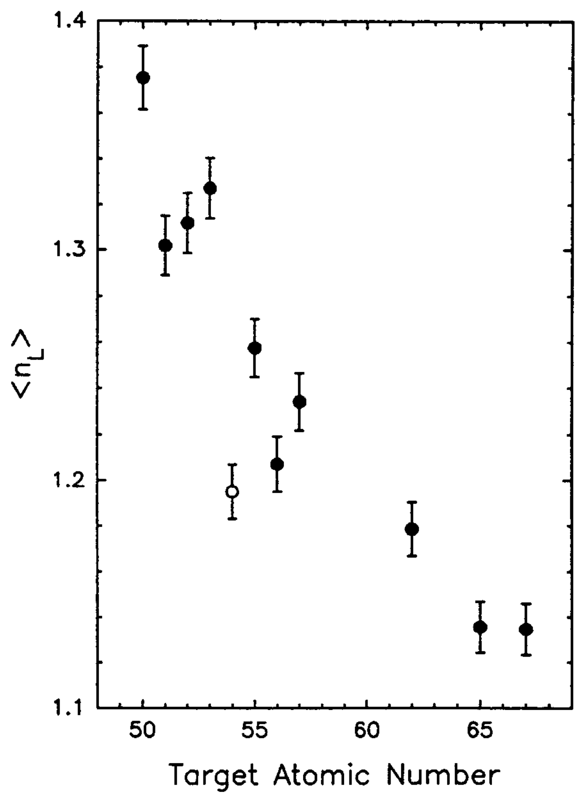

Figure 2. Average number of L-shell vacancies at the time of L x-ray emission after ionization by 6 MeV/u Kr projectiles. The open circle corresponds to the gaseous Xe target.

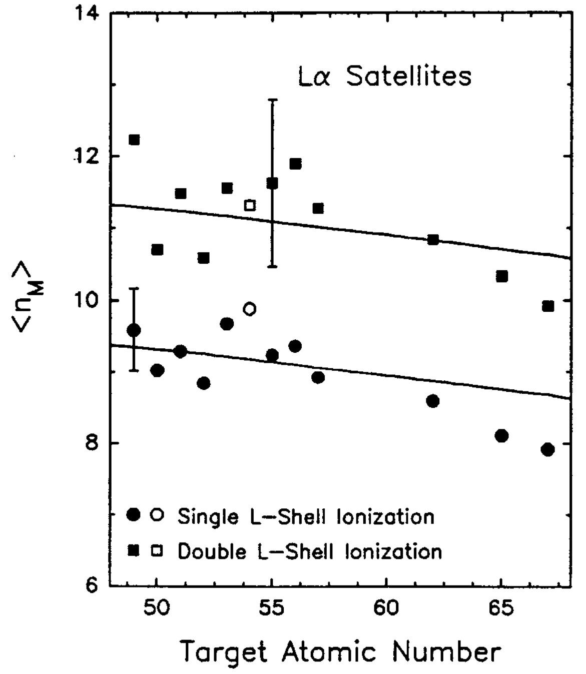

Figure 3. Average number of M-shell vacancies at the time of x-ray emission in the indicated targets ranging from $_{49}$In to $_{67}$Ho after ionization by 6 MeV/u Kr projectiles. The open points correspond to the gaseous Xe target. The solid lines represent semi-empirical predictions based on the geometrical model.

because the Kr projectiles have a higher average charge while traveling in a solid target than in a gaseous target [5].

The average number of M-shell vacancies (<n_M>) extracted from the 6 MeV/u Kr spectra are shown in Figure 3 as a function of the target atomic number. The circles show the results for the satellites associated with single L-shell ionization, while the squares show the results for satellites associated with double L-shell ionization. Also shown in this figure are curves representing the semi-empirical scaling predictions discussed in the next report [6]. While the data seem to have a steeper slope than the semi-empirical curves, the overall agreement is quite good.

Figure 4 shows the values of <n_M> extracted from fits of the Sb satellites for various 10 MeV/u projectiles for both single and double L-shell ionization. The results are plotted as a function of projectile atomic number and again

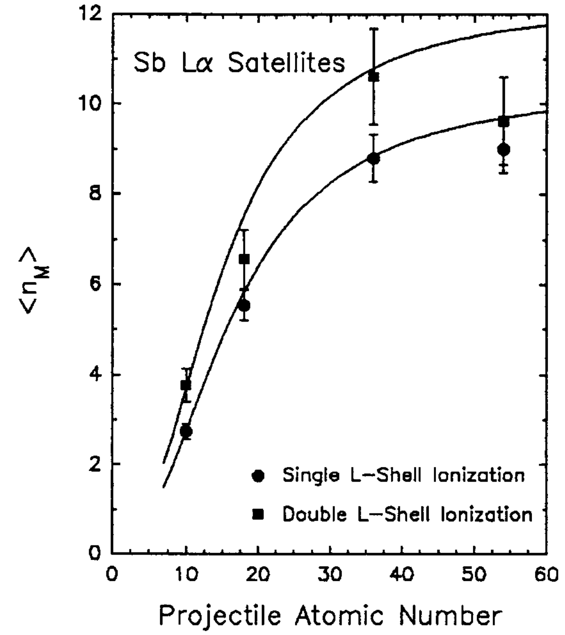

Figure 4. Average number of Sb M-shell vacancies at the time of Lα x-ray emission after ionization by 10 MeV/u projectiles of the indicated atomic number. The solid lines represent semi-empirical predictions based on the geometrical model.

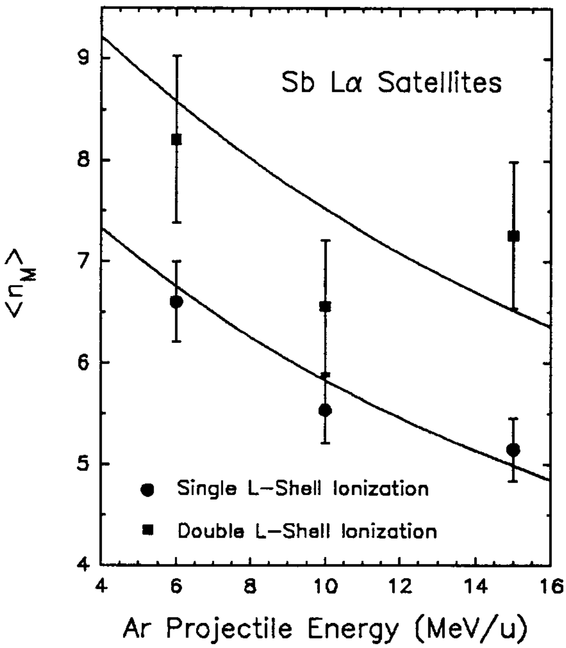

Figure 5. Average number of M-shell vacancies at the time of Lα x-ray emission in Sb target atoms that have been ionized by Ar ions with the indicated projectile energy. The solid lines represent semi-empirical predictions based on the geometrical model.

compared to the semi-empirical predictions [6]. It is interesting to note that a saturation appears to occur at values of $<n_M>$ just above 9 or one half of the M shell.

Figure 5 shows the projectile energy dependence of $<n_M>$ values extracted from fits of the Sb targets excited by Ar ions. The results are compared to the semi-empirical predictions [6].

References

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