

# X-ray satellites and hyper satellites and chemical effects

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Study of X-ray satellites and hyper satellites is an area in atomic spectroscopy linked to inner shell ionization. This helps in improving our understanding of inter-shell correlations, excitation and relaxation dynamics etc. in an atom. When an atom ionized simultaneously in different shells de-excites, x-ray satellites are produced. If some holes are present in the L-shell along with a hole in the K-shell, the transitions to the K-shell from the higher shells give rise to K x-ray satellites, with the holes in the L-shell acting as spectators as they don't by themselves participate in the transition. The absence of L-shell electrons reduces the screening of the nuclear potential felt by the remaining electrons and increases their binding energies. K X-rays emitted due to transitions of electrons from such states will be at higher energies than the normal diagram lines and are called satellite lines. L-K and M-K transitions give rise to  $K\alpha$  and  $K\beta$  satellites respectively denoted as  $K\alpha L^n$  and  $K\beta L^n$  where n stands for the number of holes in the L-shell. These satellites have multiplet structure associated with the angular momentum coupling of the multiple vacancy states involved. Similarly when an atom multiply ionized simultaneously in L and M shells de-excites, L X-ray satellites are produced with holes in the M-shell acting as spectators. If the atom is doubly ionized in the K-shell and if these holes are filled by transitions from higher shells, KX-ray hyper satellites are emitted. Such transitions originating from L,M Shells are denoted by  $K\alpha^h$ , and  $K\beta^h$ , hyper satellites respectively. X-ray satellites and hyper satellites have been investigated by various techniques as photoionization, electron, proton and heavy ion bombardment, electron capture and internal conversion. Usually crystal spectrometers are employed in these investigations. Energy shifts and relative intensities of these lines with respect to the diagram line are determined and compared with estimates of available theoretical models. Some Z systematics have been developed. Noticeable effects of chemical environment on the relative intensity of these satellites were reported from some of these studies. They were correlated with parameters like oxidation number, coordination number, covalence, Coster-Kronig transitions and the phenomenon of resonant electron transfer. Physical state effects were observed in a studies conducted with solid and gaseous forms of the same element. There is scope for further investigation in this area with ion bombardment using particle accelerators and photoionization with hard X-rays from synchrotrons. There is potential for theoretical work also.

