

## ***L*-shell ionization of atoms and their subsequent decay by radiative and non-radiative transitions**

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**Abstract.** The study of the ionization of atoms resulting in vacancies in their inner shells and the subsequent decay of the atomic-vacancy states by x-ray and Auger transitions continue to be an active area of interest. A rapid survey of the theoretical efforts to calculate the transition probabilities involving *L*-subshells in the high-*Z* atoms is presented. A complete review of the *L*<sub>1</sub>-subshell yields for single-vacancy atomic states obtained by various experimental techniques is included. The production of multiple vacancies in the *L* shell and the role of the spectator vacancies in the decay process is discussed. A detailed case study of determining experimentally the number of multiple vacancies produced, and the x-ray fluorescence yields during ionization by heavy-ion bombardment is presented. It is established that the effect of spectator vacancies is to increase the x-ray fluorescence yields substantially.

**Keywords.** Atomic physics; x-ray transitions; x-ray fluorescence yields.

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### **1. Introduction**

In 1972 at Atlanta, Bernd Crasemann said the following in his summary of the international conference on the inner-shell processes: 'It seems to me that the main problems related to a single inner-shell vacancy production and decay now have very nearly been solved, both experimentally and theoretically, and that we have a good basic understanding of ionization and of radiative and Auger transition probabilities and fluorescence yields.... The big challenge, I think, now lies in multiple vacancies. There, experiment has gotten ahead of theory and will have to stay ahead to provide a guide in solving some really complex and fascinating problems: collision mechanisms, transition-energy shifts, the formation of a vast array of satellite lines, and fluorescence yields in the presence of several vacancies'. I would like to take you through a guided tour, through the various stages of our understanding during the last 25 years since these remarks were made. It could be cast in the form of an autobiographical sketch of my own interests, but I will resist the temptation and just let you know that my nuclear physics studies required the knowledge of x-ray fluorescence yields of *L* subshells and that was how I got interested in this subject. It is safe to generalize that 'the original impetus for the study of the inner shell vacancy atomic states has its origins in the interpretation of a variety of experiments in nuclear and atomic physics.' A precise knowledge of atomic transitions, their transition probabilities and branching ratios became crucial as both theoretical and experimental