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Observation in Lead Atoms of the $L^{-2}\rightarrow M^{-2}$ Two Electron-One Photon Transition ($L_{\alpha\alpha}$ Line)*

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The observation in the radiative decay of atoms doubly ionized in the K shell of the direct two electron-one photon ($K^{-2}\rightarrow L^{-2}$: $K_{\alpha\alpha}$ line) transition was first reported by Wolfli and coll.[1] in 1976. This type of transition which is of importance when studying correlation effects between electrons in atoms, is in principle very difficult to observe when using the most conventional modes of ionization, *e.g.* electron bombardment or photoionization, because the probability of double K ionization is very small (typically $10^{-4}\sim10^{-5}$ with respect to the single K ionization). When using heavy ion bombardment like Wolfli and coll. did for instance, this probability is much higher and reach few per cent. Unfortunately, there are, in such cases, a lot of additional vacancies which are produced in the outermost shells (and namely the L shell) and the experimental data cannot be directly compared to the theoretical predictions, the initial state configuration being not accurately known (the $K_{\alpha\alpha}$ line being the $(1s)^{-2}\rightarrow(2s)^{-1}(2p)^{-1}$ transition is then very sensitive, in intensity, to the mean value, generally unknown, of the actual number of 2s electron in the initial state).[2-4]

We have observed a two electron-one photon transition of the $L^{-2}\rightarrow M^{-2}$ type in a case where the initial configuration state is well known. The principle of this experiment is to study the X-ray spectrum in coincidence with KLL Auger lines. When looking at the X-ray spectrum in coincidence with KLL Auger lines one observes,[5] mainly, the satellite and hypersatellite lines which predominantly depopulate the L^{-2} states but one should also observe, with a much smaller probability the direct $L^{-2}\rightarrow M^{-2}$ (or any other allowed final configuration of this type) two electron-one photon transition at roughly twice the energy of the usual L X-ray lines. We have observed such lines and namely the $L_3^{-2}\rightarrow M_{4,5}^{-2}$ ($L_{\alpha\alpha}$) transition which is shown in the following figure. This line has been observed as well with as without absorber and has exactly the energy that can be predicted using the well known satellite, hypersatellite X-rays and KLL Auger line energies (energetic cycle method). This line when compared with the true addition line ($L_\alpha^h+L_\alpha^s$ true electronic addition whose exact energy is known) has also a probability which is in good agreement with the prediction we can do at first order, using the shake down model developed by Åberg.[3]

*Abstract only.

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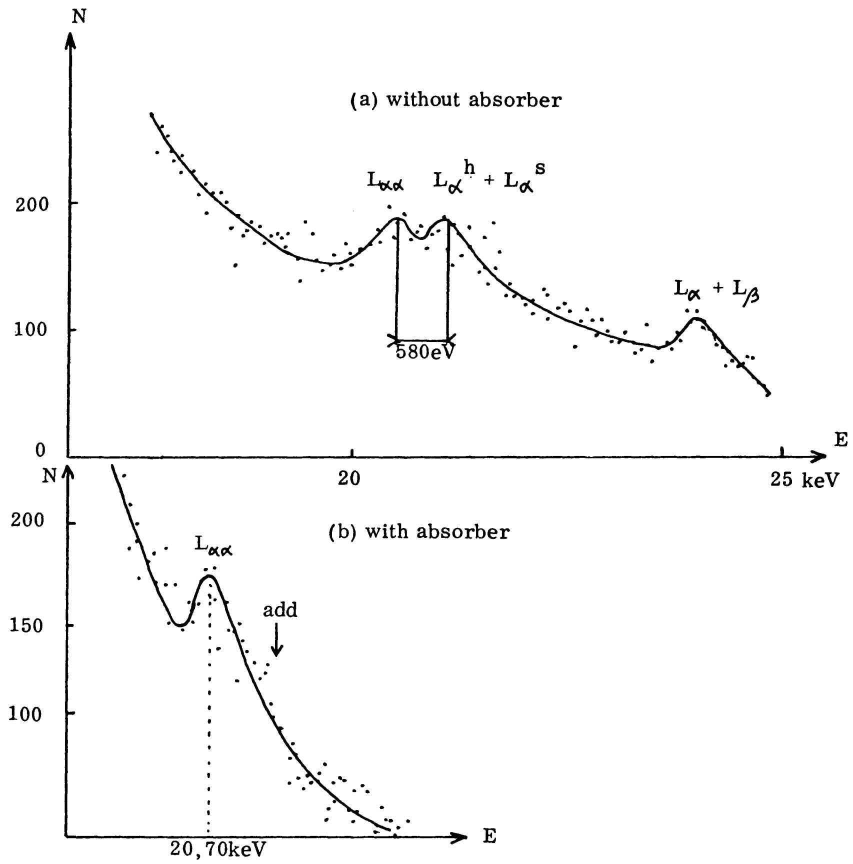

Fig. 1. $L_{\alpha\alpha}$ line $(2p)^{-2} \to (3p)^{-1}\,(3d)^{-1}$ observed in coincidence with and without absorber.