ESRF	**Experiment title:** **Correlated transitions in hollow atoms**	**Experiment number**: HE-1150
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Report:

In spite of the great importance of, and recent revival of interest in electron correlation effects in atoms, studies of final state correlations, and in particular correlated *emission* studies, are still rather few. Such transitions can be studied through so-called correlated K hypersatellite lines (CHS), which originate when two K vacancies in the same atom are filled simultaneously by two electrons, but with only a *single* photon being emitted. CHS transitions, i.e. $1s^{-2} \rightarrow 2s^{-1}2p^{-1}_{1/2,3/2}$, yield lines denoted as $K^h\alpha_2\alpha_3$ and $K^h\alpha_1\alpha_3$, respectively. The comparison of HS and CHS can yield important information on the emission process. For example, since both HS and CHS spectra originate in the same two K hole initial state the branching ratio $B=\sigma(K^h\alpha\alpha)/\sigma(K^h\alpha)$ should be free from effects originating in the excitation process, and allow obtaining direct experimental information on, and testing theories of the de-excitation process. Several calculations are available for B [1], but since CHS are extremely weak, 10^{-3}-10^{-4} % of the diagram line's intensity for the 3d transition elements, the only available experimental study claiming to have measured a resolved CHS spectrum is that of Salem et al. [2]. However, they find for these lines an unacceptable 1000-fold higher branching ratio than theoretically predicted.

Considering the strongly decreasing cross section with Z for exciting the CHS as well as several practical issues, like the availability and quality of spherically bent analyzers we chose to measure the CHS in V with a Si(555) analyzer. The excitation threshold for the double-K-hole initial state in this element is 11.229 keV, while the CHS lines is expected to appear at 10.026 keV. Throughout the run, much time and effort was invested in minimizing the background around the last-mentioned energy, and in accurately calibrating the analyzer's energy and relative intensity scales. In spite of all this effort, the raw data shown in Fig. 1, taken at incident energies 11 keV (below the threshold) and 17 keV (above the threshold) does not seem to show a clear indication of the CHS.

The two "bumps" appearing in the 17-keV spectrum seem to originate from the Cu K lines, excited by higher-order residual harmonics transmitted by thee monochromator and reflected by the Si(444) reflection in the analyzer.

Thus, while our results seem to place $^{-3}$ % (relative to the K diagram lines) on the CHS intensity at an incident energy of 17 keV, and thus rule out the results of Salem et al. [1], a useable CHS spectrum was not obtained.

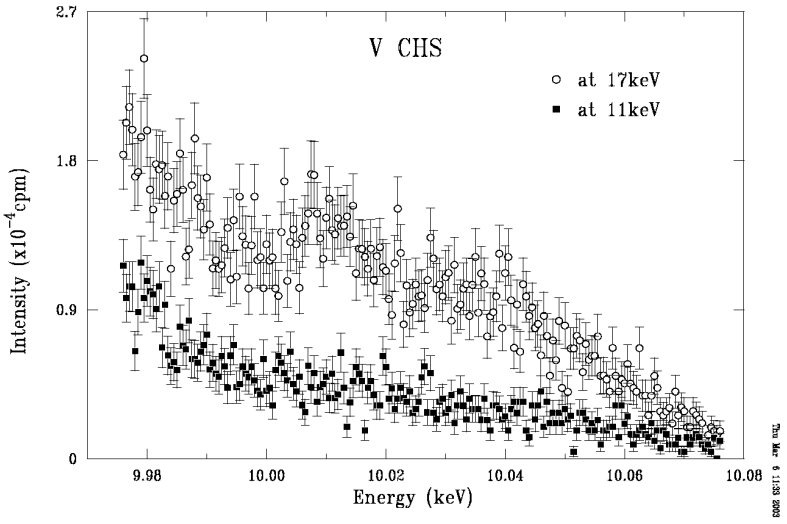

Fig. 1 : Emission spectrum measured for Vanadium, for the two excitation energies listed.

With the experience gained in this experiment, in particularly on the various components comprising the background, we believe that we will be able to optimize the experimental setup and measuring procedures to a level allowing the measurements of the elusive CHS spectra with satisfactory statistics.

[1] T.K. Mukherjee and P.K. Mukherjee, *Z. Phys. D* **42**, 29 (1997) ; T. Aberg, K. A. Jamison and P. Richard, *Phys. Rev. Lett.* **37**, 63 (1976).

[2] S.I. Salem et al., *Phys. Rev. A* **29**, 2634 (1984) ; S.I. Salem, et al., *Phys. Rev. Lett.* **49**, 1240 (1982).