The Lα' Satellite of Tungsten

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Introduction: The L emission spectra of tungsten were studied mostly in the context of Coster-Kroning transition probabilities. The recent study of Vlaicu et al. [1] is among the few addressing contributions to the $L\alpha_{1,2}$ line shapes from satellites due to N-shell spectator hole transitions. These, however, strongly overlap the diagram lines, and cannot be separated out. By contrast, satellites originating in the M-shell, or more inner shell, spectator transitions are in principle, separable from the W $L\alpha_{1,2}$ lines, and can be studied by high-resolution measurements. Although detected in early photographic measurements [2,3], their low intensity ($\leq 10^{-3}$ of that of the $L\alpha_1$ line) and high background due to the wings of the $L\alpha_{1,2}$ spectrum effectively prevented their detailed study. We present here the first high-resolution measurements of such a satellite, the W Lα'.

Methods and Materials: Using monochromatic photon excitation, the emission spectrum was recorded by a Johann type spectrometer employing a spherically bent Si(444) analyzer. The high, 72º, Bragg angle (according to the peak energy) provided a high resolution of 2.8 eV. The measured spectra were corrected for the counting electronics dead time, the incident beam intensity's time decay, and the incident and emitted radiation's absorption in the sample.

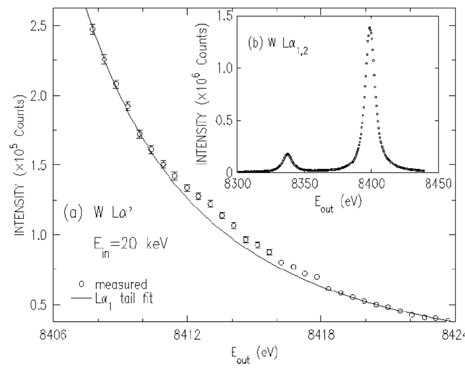

Figure 1. The $L\alpha_{1,2}$ spectrum of tungsten. (a) The $L\alpha_1$ tail showing the satellite, and (b) The full Lα diagram spectrum

Results: The measured W $L\alpha_{1,2}$ spectra for E_{in} = 20 keV , is shown in Fig. 1 (b). After fitting a lorenzian centered on the $L\alpha_1$ peak, we detected the satellite on the high-energy tail, as shown in Fig. 1 (a). Subtracting off the lorenzian, we obtain the satellite Lα' spectrum shown in Fig. 2 (a). The peak position is at E = 8413.3±0.4 eV, which agrees well with Cauchois' [3] early value of 8413.4 eV. To elucidate the origin of the Lα' satellite we used the spectator multiplet energies and relative intensities calculated by Parente et al. [4] to generate 'stick diagrams' of all relevant transitions. Only M_i, i=1-5, spectators yield lines in the energy range of interest, 8405-8435 eV. These are shown along with the measured, background-subtracted Lα' spectrum in Fig. 2. As can be clearly observed, the original assignment of the Lα' spectrum to the M_3 spectator transition (Fig. 2(d)) is not supported by these calculations, but is better aligned with the M_5 spectator transitions (Fig. 2(f)).

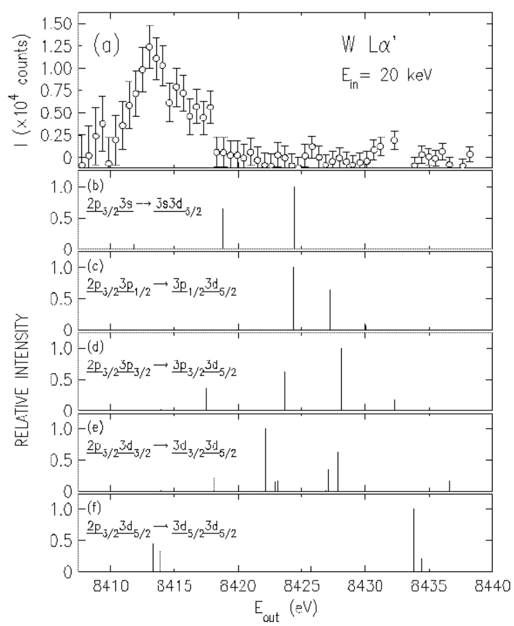

Figure 2. The Lα' satellite. (a) The Measured, background-subtracted satellite. (b-f) the 'stick' diagrams calculated *ab-initio* for the transitions specified.

Conclusions: We suggest a new assignment of the Lα' spectrum to the M_5 spectator transition [5]. A verification of this assignment will require accurate calculations of the relevant multiplets, including more accurate intensities than those currently available.

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References:

[1] A.M. Vlaicu et al. Phys. Rev. A **58**, 3544 (1998). [2] Y. Cauchois C.R.Acad.Sci. **201**, 721 (1935). [3] Y. Cauchois & C. Senemaud, "Wavelengths of X-ray Emission Lines and Absorption Edges" (Oxford; Pergamon) (1978) [4] F. Parente et al. At. Data Nucl. Data Tables **26**, 383 (1981). [5] R. Diamant, S. Huotari, K. Hämäläinen, C.C. Kao and M. Deutsch J. Phys. B, **33**, L649 (2000).

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