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Translated by H. Lashinsky
284

MEASUREMENT OF THE INTENSITY RATIO OF THE TRANSITIONS TO THE FIRST EXCITED LEVELS OF DAUGHTER NUCLEI IN THE DECAY OF U^{238} AND U^{234}

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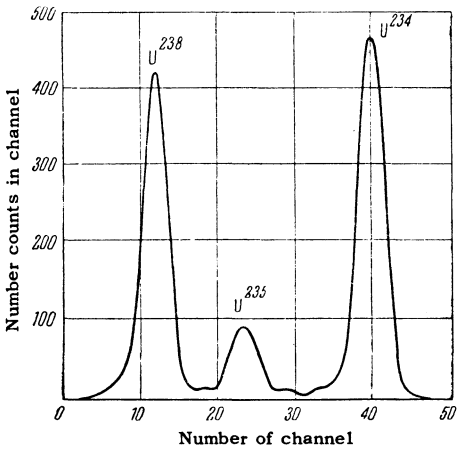
Submitted to JETP editor June 12, 1959

J. Exptl. Theoret. Phys. (U.S.S.R.) **37**, 1456-1457 (November, 1959)

THE ratio of the intensities of the transitions to the first excited levels was measured by us with a pulse ionization chamber with a screen connected for coincidence with a scintillation counter with a NaI crystal. The latter registered the x-rays accompanying the α decay to the first excited levels of the daughter nuclei. In plotting the α spectra without coincidences, the lines corresponding to the transitions to the first excited level and to the ground state are incompletely resolved. Data on the transition intensities[1] obtained in this manner are therefore insufficiently accurate. Transitions to the ground state are not registered if coincidences with x-ray L-quanta are introduced, so that it becomes possible to determine reliably the relative intensities of the transitions to the first excited levels.

The α spectrum of a natural mixture of uranium isotopes, plotted in coincidence with x-ray L radiation, yielded the following information: 1) the number of pulses N_1 corresponding to the transition of U^{234} to the first excited level of Th^{230} is 1815; 2) the number of pulses N_2 corresponding to the transition of U^{238} to the first excited level Th^{234} is 1640. It is necessary to subtract from N_2 approximately 30 pulses, due to the decay of U^{235}. The calculations performed have shown that the errors in the intensities, due to the presence of two conversion lines L_{II} and L_{III} (different absorption, Auger effect, etc.) and to conversions on the M and N shells, are quite insignificant and result in a total correction of 0.7%. Taking



this correction into account, we obtain for the intensity ratio $N_2/N_1 = 0.91 \pm 0.04$. The populations of the same levels were investigated previously by Teillac[2,3] by a method in which the conversion electrons were registered in thick photoemulsions. These measurements yielded a value of 0.75 for N_2/N_1. However, owing to the poor distribution of the groups of α particles and the small number of registered events, the accuracy of this ratio was small ($\sim 25\%$).

The intensity of the transition to the first excited level in the decay of U^{234}, measured with a magnetic spectrometer, amounts to 28%.[4] We therefore obtain a value of 25.5% for the intensity of the analogous transition in the decay of U^{238}. (The accuracy of this value is determined essentially by the accuracy of the measurements made by Gol'din, Tret'yakov, and Novikova,[4] which, unfortunately, was not stated by the authors.) Investigations in which the photoemulsion method was used[3,5] yielded a value of $(23 \pm 3)\%$. It can be shown that in these investigations the number of conversion electrons due to the U^{235} decay was incorrectly computed. This value should have been computed, since the U^{235} line was not separated from the U^{238} line. It was thought that each U^{235} decay was accompanied by a conversion electron. Investigations performed recently in our laboratory and in others on the α decay of U^{235} make it possible to state that the number of conversion electrons of energy within U^{234} conversion-electron energy range is only approximately half the number of the U^{235} decays. Taking this into account, the results of references 3 and 5 can be reduced to a value of $(25 \pm 3)\%$.

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Translated by J. G. Adashko
285

INVESTIGATION OF THE X-RAY SPECTRA OF THE SUPERCONDUCTING COMPOUND CuS

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Submitted to JETP editor June 16, 1959

J. Exptl. Theoret. Phys. (U.S.S.R.) **37**, 1458-1460 (November, 1959)

In the formation of a chemical compound there is always a rearrangement of the electron energy spectrum of the elements that enter into the composition. These changes are accurately determined from the fine structure of the x-ray emission and absorption spectra.

In the case of superconducting compounds of nonsuperconducting elements, according to the presently developing concepts,[1] the fine structures of the x-ray spectra of the metals will change so as to come closer to the fine structures of the spectra of a superconducting metal, whose position in the periodic table is close to that of the metal under consideration (in the same period).

We report in the present paper the results of an investigation of the fine structure of x-ray absorption and emission K spectra of sulfur and copper in the pure elements and in the compound CuS. These results confirm the foregoing point of view. Sulfur and copper are nonsuperconducting elements, while CuS is a superconductor with a transition temperature 1.62°K. The CuS lattice is of space group D_{6h}^4 (reference 2).

The investigations were carried out in an x-ray vacuum spectrograph with bent quartz crystal (radius of curvature 500 mm, Kapitza-Johann focusing). Photographic registration was used. The sulfur spectra were obtained in reflection from the $(10\bar{1}1)$ plane, those of copper from the $(13\bar{4}0)$ plane. The accuracy of measurement of the position of the sulfur edge was 0.4 xE, that of copper — 0.15 xE, and that of the positions of the maxima of the emission lines of sulfur was 0.2 xE. The emission K spectrum of sulfur was studied by a secondary method.

The diagram shows the average microphotograms of the resultant spectra; the curves are arranged in such a way that the inflection points of the long-wave portion of the S and Cu edges coincide in the CuS. This point, accurate to the width of the initial state, determines the position of the Fermi surface of the energy spectrum of the compound. All the curves that represent the fine structures of the spectra are arranged about this point in equal energy scale.

The experimental results obtained allow us to note the following (see table):

1. The sulfur spectrum in CuS does not have a discontinuity between the center of the short-wave branch of the last emission line and the point of inflection of the long-wave portion of the edge. This corresponds to a metallic character of the conductivity of the CuS compound.

2. In the absorption spectrum of the sulfur in CuS a maximum, which is new compared with the spectrum of pure sulfur, appears for the absorption coefficient in the long wave portion of the edge abc (see diagram).

3. The intensity ratio J_{β_x}/J_{β_1} of the sulfur spectrum in the CuS is reduced to one half the value in the pure sulfur spectrum.

4. The absorption edge of copper in CuS has lost completely the fine structure that is characteristic of the edge of pure copper. The form of the edge exhibits great similarity with the K edge of Zn or Ga.

5. There is a similarity in the form of the Cu and S edges in CuS (the maxima of the absorption coefficients A and A′ or B and B′ are located at approximately equal distances from the point F; the regions def and d′e′f′ have the same

Wavelengths of different elements of the fine structure

Fine-structure element	In the pure element		In the compound		Shift
	xE	ev	xE	ev	$\Delta\lambda$, ev
Start of sulfur absorption edge	5008.0	2470.1	5012.4	2467.9	—2.2
Maximum of $K\beta_1$ sulfur line	5019.8	2464.3	5021.6	2463.4	—0.9
Maximum of $K\beta_x$ sulfur line	5013.7	2467.3	5013.4	2467.4	—0.1
Start of copper absorption edge	1377.94	6515.1	1377.55	6516.9	+1.8
Maximum of $K\beta_5$ copper line	1378.22	6512.8	1378.20	6513.9	+1.1
Maximum of $K\beta_1$ copper line	1389.65	6405.7	1389.26	6904.3	+3.6