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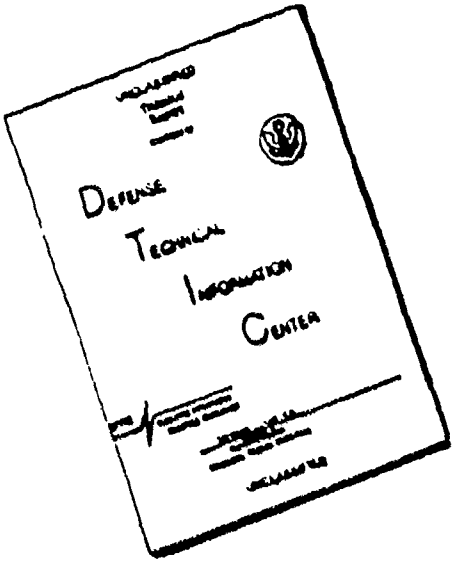

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TITLE: Measuring the Partial Beta-Spectrum of ThB by the Method of Concidences With the Aid of a Double Beta-Spectrometer

AUTHOR(S) : Grosbev, L.V.; Shavtvalov, L. Ya

ORIG. AGENCY : Moscow State University, Lomonosov, M.V. Physics Dept.

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ABSTRACT:

The method of measuring the partial beta-spectrum of ThB by coincidences, with the aid of a double beta-spectrometer is described. The conversion electrons of H = 1, 385 oersteds per cm were focused on the beta-counter C_1 by the magnetic lens L. The current in the other magnetic lens L_2 was varied so that electrons of different energies of the complex beta-spectrum for the thorium deposit fell alternately upon the second beta-counter C_2. In this way a beta-spectrum was obtained. The ThB spectrum is presented in the original documents in the form of a Fermi graph, which is rectilinear throughout, from its upper limit down to 80 kev. By extrapolating the curve to abscissa, 340 kev is obtained as the upper limit of the beta-spectrum.

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Measuring the Partial Beta-Spectrum of ThB by the Method of Coincidences With the Aid of a Double Beta-Spectrometer

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SOURCE Doklady Akademii Nauk SSSR, Vol LXVIII, No 2, 1949

MEASURING THE PARTIAL BETA-SPECTRUM OF TAB BY THE METHOD OF COINCIDENCES WITH THE AID OF A DOUBLE BETA-SPECTROMETER

L. V. Groshev
L. Ya. Shavtvalov
Moscow State U imeni M. V. Lomonosov

The atomic nuclei which emerge as a result of beta-decay are usually found in excited states, which are made known by the fact that beta-decay is accompanied by the emission of gamma-rays. In those cases where decay leads to the formation of an end nucleus in several different energy states, we obtain a complex beta-spectrum, which is the result of the superposition of a number of elementary, partial beta-spectra corresponding to transitions to different nuclear levels of the product. To solve the problem of the form of the beta-spectrum, the complex spectrum must be broken down into the elementary spectra. Such an analysis is also interesting from the standpoint of establishing the system of nuclear energy levels of the product. The elementary spectra are frequently separated by resolving the proper Fermi graph into separate linear sections. This method, however, is not particularly reliable or accurate. Therefore, it would be desirable to measure the elementary beta-spectra directly.

If, as a result of beta-decay, the end nucleus is formed in the ground state and in one of the excited states, separation of the partial spectra may be accomplished easily by using the method of beta-gamma coincidences. The number of beta-gamma coincidences is measured for various energy sections of the continuous beta-spectrum, separated by some sort of beta-spectrometer. Such measurements immediately yield the partial beta-spectrum corresponding to the transition to the excited nuclear level of the product.

The problem becomes considerably more complex when the end nucleus forms in several excited states. In this case, the beta-gamma coincidences belonging to photons of definite energy which are emitted in the radiation of the given excited state must be distinguished.

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This can be done if, instead of a gamma-counter, a second beta-spectrometer is used to separate the conversion (or other secondary) electrons from the corresponding gamma-line. Given such an apparatus, the partial beta-spectrum may be resolved by measuring the number of beta-beta coincidences for a fixed conversion line and for different sections of the continuous spectrum.

With this purpose in mind, we constructed a double beta-spectrometer. (Figure 1, appended). It is a combination of two identical beta-spectrometers with magnetic lenses. A copper pipe with a diameter of 18.4 centimeters and an over-all length of 2 meters was used as a vacuum chamber T. The inside of the pipe was lined with a 3-millimeter aluminum layer. The beta-counters C_1 and C_2 were placed endwise at both ends of the pipe. The magnetic lenses L_1 and L_2 were aligned separately with the aid of a special device which aligned the axis of each lens with the axis of the pipe. A current coil, placed in the horizontal plane passing through the axis of the pipe, was used to compensate for the vertical component of the earth's magnetic field. The source S was placed in the center point of the pipe. It could be replaced without disturbing the vacuum through the use of a special locking unit LU.

The coincidences in counters C_1 and C_2 were registered by an electronic circuit with a resolving power of 3×10^{-7} second.

The double beta-spectrometer was used to study the beta-spectrum of an active thorium deposit, precipitated on a thin aluminum foil in the form of a small circle 8 millimeters in diameter.

The spectrum of a thorium deposit is the superposition of the beta-spectra of three radioactive elements: ThB, ThC'', and ThC, whose upper limits are, respectively, equal to 340, 1,820, and 2,250 keV. In transitions ThB→ThC, the majority of the decays occurs at the excited nuclear level of ThC with an excitation energy of 238 keV. The gamma-rays emitted in radiation of this state are very active in conversion in the electron shell, yielding an intense line H = 1,385 oersteds per centimeter, corresponding to the extraction of an electron from the K-level. We used this conversion line to separate the fundamental partial beta-spectrum of ThB from the complex spectrum of the thorium deposit.

In the measurements, the conversion electrons of H = 1,385 oersteds per centimeter were focused on the counter C_1 by the magnetic lens L_1. The current in the other magnetic lens L_2 was varied so that electrons of different energies of the complex beta-spectrum for the thorium deposit fell alternately upon the counter C_2.

A beta-spectrum was obtained. The curve was corrected for absorption of electrons in the window of the counter. The comparatively small statistical accuracy of separate measurements is due to the fact that a weak preparation was used (approximately 25 micro Curies). Stronger sources could not be used because the number of chance coincidences increases proportionally to the square of source activity, while the number of genuine coincidences increases linearly. The following numbers represent the relation between chance and genuine coincidences for the region close to the spectrum maximum: $N_c = 0.51$ pulse per minute and $N_g = 0.73$ pulse per minute.

The ThB spectrum is presented in the form of a Fermi graph, which is rectilinear throughout, from its upper limit down to 80 keV. Thus, the elementary character of the beta-spectrum under consideration is confirmed. By extrapolating the curve to the abscissa, we obtain 340 keV as the upper limit of the beta-spectrum. This figure agrees well with other data.

The complete spectrum for the active thorium deposit was obtained with the aid of the second beta-spectrometer. Its upper limit lies at approximately 2,250 keV. The spectrum of beta-beta coincidences for ThB was also reproduced for comparison. Allowance was made for absorption in the windows of the counters in both cases. In these graphs the number of electrons of the spectra of ThB and Th(B+C+C'') in arbitrary (and different for both curves) dimensions is placed along the abscissa.

While this work was being completed, an article by N. Feather, J. Kyles, and R. W. Pringle (Proc. Phys. Soc., 61, 466, 1948) appeared, describing the results of similar measurements with an active thorium deposit. Unlike our work, however, their measurements were conducted in a unit consisting of two Danish-type beta-spectrometers. Therefore, to resolve the different sections of the continuous beta-spectrum, they had to resort to the shifting of Geiger counters, thus complicating the work.

[Appended figure follows.]

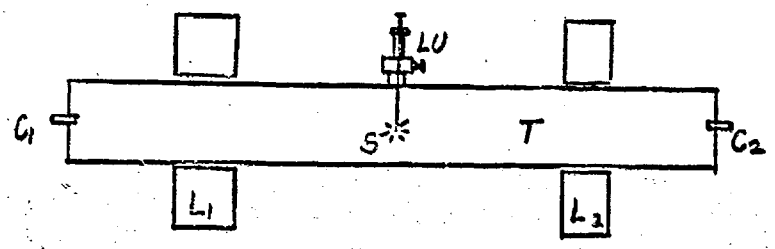

Figure 1

[Graphs for the number of beta-beta coincidences per hour, Fermi graph for ThB, and complete spectrum for the active thorium deposit are available in the original document in CIA.]

- END -

Central Intelligence Agency

Washington, D.C. 20505

7 September 2004

Ms. Roberta Schoen
Deputy Director for Operations
Defense Technical Information Center
7725 John J. Kingman Road
Suite 0944
Ft. Belvoir, VA 22060

Dear Ms. Schoen:

In February of this year, DTIC provided the CIA Declassification Center with a referral list of CIA documents held in the DTIC library. This referral was a follow on to the list of National Intelligence Surveys provided earlier in the year.

We have completed a declassification review of the "Non-NIS" referral list and include the results of that review as Enclosure 1. Of the 220 documents identified in our declassification database, only three are classified. These three are in the Release in Part category and may be released to the public once specified portions of the documents are removed. Sanitization instructions for these documents are included with Enclosure 1.

In addition to the documents addressed in Enclosure 1, 14 other documents were unable to be identified. DTIC then provided the CDC with hard copies of these documents in April 2004 for declassification review. The results of this review are provided as Enclosure 2.

We at CIA greatly appreciate your cooperation in this matter. Should you have any questions concerning this letter and for coordination of any further developments, please contact Donald Black of this office at (703) 613-1415.

Sincerely,

Nancy Jackson for

Sergio N. Alcivar
Chief, CIA Declassification Center,
Declassification Review and Referral
Branch

Enclosures:

1. Declassification Review of CIA Documents at DTIC (with sanitization instructions for 3 documents)
2. Declassification Status of CIA Documents (hard copy) Referred by DTIC (with review processing sheets for each document)

Processing of OGA-Held CIA Documents

The following CIA documents located at DTIC were reviewed by CIA and declassification guidance has been provided.

OGA Doc ID	Job Num	Box	Fldr	Doc	Doc ID	Document Title	Pub Date	Pages	Decision	Proc Date	
AD0336215	78-03117A	197	1	25	4482	Scientific Information Report Physics And Mathematics (27)	4/12/1963	68	Approved For Release	3/29/2004	
AD0337652	78-03117A	200	1	4	4579	Scientific Information Report Physics And Mathematics (28)	5/10/1963	61	Approved For Release	3/29/2004	
ADB810944	78-04392A	65	1	130	21179	Investigation Of The Structure Of Metals With An Electron Microscope	1/26/1952	14	Sanitized	3/29/2004	U-04
ADC051409	78-04392A	22	1	152	6751.49	Measuring The Partial Beta-Spectrum Of ThB By The Method Of Coincidences With The Aid Of A Double Beta-Spectrometer	12/12/1949	3	Sanitized	3/29/2004	C-09

The CIA has reviewed 220 DTIC documents with 41,108 pages