Energy of the ThC″ 2.62-Mev Gamma-Ray

Arne Hedgran
Nobel Institute of Physics, Stockholm, Sweden
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In connection with a project in this Institute on establishing accurate gamma-energy standards for beta-spectroscopy some measurements have been performed in the double focusing spectrometer[1] to determine the energy of the ThC″ 2.62-Mev gamma-ray. The most recent value of this energy was given by Wolfson[2] who based his determination on the Au^{198} 411.2-kev gamma-ray as determined by the Pasadena crystal spectrometer.[3]

It was originally decided to base this investigation on the annihilation radiation, since its energy should be accurately derived from the atomic constants. Subsequent work[4] shows that this may not be the case.

The procedure of the experiment was the following:

(1) $H\rho$ comparison between the L and X lines of RdTh active deposits (Ellis' notation of the K-conversion lines of the 0.51- and the 2.62-Mev gamma-rays of ThC″).

(2) A comparison by the secondary electron technique between the annihilation radiation and the ThC″ 0.51-Mev gamma-ray.

This procedure enables one to make the comparison between lines having quite different $H\rho$ values under ideal conditions, and the comparison under (2) actually introduces a negligible error because the two radiations involved have almost exactly the same energy.

The source of ThC″ for the conversion line measurement was prepared by collecting RdTh active deposit on an aluminum foil 2×6 mm. Figure 1 shows how the comparison between the experimental X and L curves was made. The full curve is the L line and the open circles are the experimental points of the X line, which has been normalized to the same height and $H\rho$ scale as the L line and brought into coincidence with that curve. The fitting of the curves is very accuıate at this resolution (~0.17 percent), so the error in the determination comes entirely from the field measurement. The $H\rho$ ratios between the L and X lines, which were obtained, are given in Table I. The first four runs were made about half a year earlier with less precise field measurement. (A description of the present improved field measuring system will be given elsewhere.) The assigned error in the mean value includes the estimated systematic uncertainty.

Table I. Measurements of the $H\rho$ ratio between the L and X lines.

Run	Ratio	Weight	Run	Ratio	Weight
1	0.26070	1	4	0.26078	1
2	0.26072	1	5	0.26070	2
3	0.26062	1	6	0.26068	2
			7	0.26064	2
		Weighted mean 0.26069 ±0.00010			

For the comparison between the ThC″ 0.51-Mev radiation and the annihilation radiation, sources of Cu^{64} and RdTh enclosed in identical brass capsules were used, and their external conversion K lines from a 2.4 mg/cm^2 uranium converter were alternately measured with a spectrometer resolution of 0.6 percent. The influence of the Doppler broadening of the annihilation radiation was taken into account, and the comparison between the lines was done in the same way as is described in reference 4. The results are shown in Table II. From the mean values of Tables I and II, the $H\rho$ of the ThX line becomes[5] 10.001±5.

This value is higher than Wolfson's[2], and an experiment similar to his was later performed utilizing the Au^{198} K-conversion line as a standard. The source was prepared by evaporating activated gold (~40 μg/cm^2) on an aluminum foil and then collecting the RdTh active deposit on the surface. The comparison was then made between the Au^{198} K-conveısion line and the ThL line.

Table II. Measurements of the $H\rho$ ratio between the secondary electrons from the annihilation radiation and those from the ThC″ 0.510-kev γ-ray. (U-radiator.) Calculation based on an annihilation energy of 510.96 kev.

Run	Ratio	$H\rho$ of the L line
1	1.0002 ±0.0002	
2	1.0002 ±0.0003	
	Mean 1.0002 ±0.0002	2607.2 ±0.5

Figuıe 2 shows the two curves compared in the same way as those in Fig. 1. The result is given in Table III and indicates a discrepancy between the Au^{198} crystal spectrometer value and the energy of the annihilation radiation obtained from the atomic constants (compare Tables II and III). The much more precise measurement described in reference 4 proves this discrepancy to be real and, for the reasons given there, the gold value is considered to be more reliable.

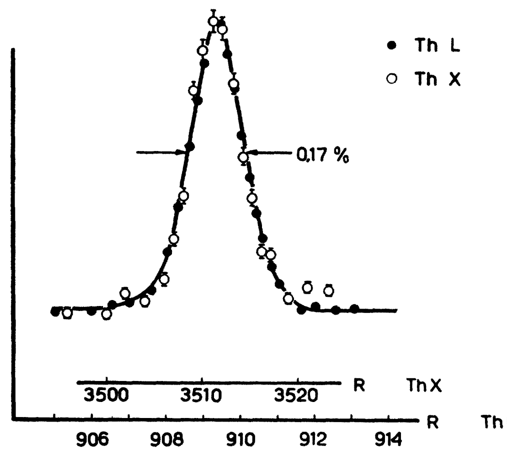

Fig. 1. The ThC″L and X lines normalized to each other and brought into coincidence for the $H\rho$ comparison.

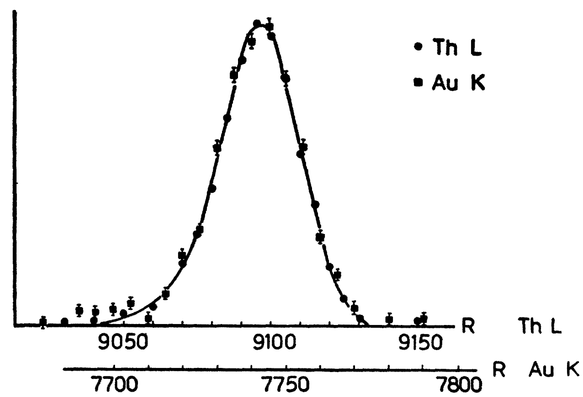

Fig. 2. The ThL and the Au^{198} K-conversion lines from the composite source. The continuous beta-spectrum subtracted and the curves compared as in Fig. 1.

Table III. Measurements of the $H\rho$ ratio between the ThL line and the Au^{198} K-conversion line and the $H\rho$ of the ThL line computed from a Au-energy 411.2 kev.

Run	Ratio	$H\rho$ of the L line
1	1.1731	
2	1.1732	
	Mean 1.17315 ±0.0002	2604.5 ±0.5

TABLE IV. Independent measurements of $H\rho$ of the ThL line based on the Au 411.2-kev energy.

Method	$H\rho$ of the L line
The data in Table II applied to the annihilation energy 510.37 obtained in reference 4	2604.8 ±0.5
Comparison between ThL and Au^{198} secondary electrons from U L_{III}	2605.0 ±0.5
Mean (Tables III and IV)	2604.8 ±0.3

Table IV gives two other determinations of the $H\rho$ for ThL based on the Au^{198} 411.2-kev value. The data are taken from the experiments described in reference 4.

These three more or less independent measurements determine the ThL line very accurately relative to the Au^{198} gamma-ray.[6] If one uses 411.2±0.1 kev as the value of the Au^{198} energy, the $H\rho$ of ThX becomes 9992±5 with the corresponding quantum energy 2.6158±0.0015. This is in good agreement with Wolfson's value 2.615±0.004.

[1] Hedgran, Siegbahn, and Svartholm, Proc. Phys. Soc. (London) 63, 960 (1950).
[2] J. L. Wolfson, Phys. Rev. 78, 176 (1948).
[3] DuMond, Lind, and Watson, Phys. Rev. 73, 1392 (1948).
[4] A. Hedgran and D. A. Lind, Phys. Rev. 82, 126 (1951).
[5] The values of the atomic constants used in this note are the same as those employed in reference 4.
[6] A precise absolute momentum measurement of the ThL line should give a valuable check on the energy value of the Au^{198} gamma-ray.

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Minutes of the Meeting of the New England Section at Mount Holyoke College, South Hadley, Massachusetts, November 4, 1950

THE thirty-fifth meeting of the New England Section of the American Physical Society was held at Mount Holyoke College, South Hadley, Massachusetts, on Saturday, November 4, 1950. Approximately eighty members of the section were in attendance. The program included four invited papers and eleven contributed papers. Abstracts of the contributed papers will appear in the *Physical Review.*

At the business meeting several minor changes in the Constitution and By-Laws of the Section were enacted to bring these documents of the Section into line with the corresponding documents of the parent Society.

The following officers were elected for 1951: *Chairman*—N. C. Little, Bowdoin College; *Vice-Chairman*—Nora Mohler, Smith College; *Secretary-Treasurer*—A. G. Hill, M.I.T.; *Executive Committee*—F. W. Constant, Trinity College, and D. H. Frisch, M.I.T.

A. G. HILL, *Secretary-Treasurer*
M.I.T., Cambridge 39, Massachusetts

Invited Papers

Toxicity of Radium and Plutonium. R. D. EVANS, *M.I.T.*

Some Experiments with 300-Mev Gamma-Rays. D. H. FRISCH, *M.I.T.*

Neutron Reflection Experiments. D. J. HUGHES, *Brookhaven.*

Nuclear Magnetic Resonance Experiments. N. F. RAMSEY, *Harvard University.*

ABSTRACTS OF CONTRIBUTED PAPERS

1. Magnetically Maintained Pendulum. H. P. KNAUSS AND P. R. ZILSEL, *University of Connecticut.*—An iron bob swinging as a pendulum along the axis of a coil toward and away from its center is maintained in motion by feeding alternating current from a low resistance source into the coil forming part of a suitably tuned circuit. The iron bob may be replaced by a second coil connected in series. The transfer of energy to the pendulum is shown to be due to the phase difference between the variation in the inductance of the circuit, and the corresponding variation in the amplitude of the current with the oscillation of the pendulum. If the variation in the current amplitude lags behind the variation in inductance, the pendulum is driven, otherwise it is damped. In the limit of small amplitude of oscillation the condition for maintenance is that the circuit have predominantly inductive reactance and sufficiently high Q.

2. Impedance Function of Metals in Electrolytic Solution.* D. C. GRAHAM, *Amherst College.*—Solid metals immersed in solutions of electrolytes exhibit an impedance which is not representable as a function of frequency (at a given potential with infinitesimal test signal) by any simple combination of capacitance, resistance, and inductance. Consideration of the physical phenomena involved indicates that the concentration of hydrogen atoms at the metallic surface, y, should vary with the imposed current according to the differential equation $dy/dt=I_0+A\sin\omega t-ky^2$. This equation does not lend itself to exact solution, but numerical solutions using reasonable values of the parameters lead to variations of concentration with time in reasonable agreement with experiment.

* A fuller account will be found in the *Monthly Notices of The Royal Astronomical Society,* Geophysical Supplement, to be published.

3. A Problem of the Temperature in an Accumulating Medium. A. E. BENFIELD, *Harvard University.*—An expression is derived for the temperature $T(x, t)$ in a semi-infinite solid accreting with constant velocity v, on whose rising surface there is impressed the temperature $T(0, t)=A+B\cos(\omega t+\theta)$, where x is depth, t is time, and A, B, ω, and θ are constants. The solution is of use in studying the temperature in an accumulating snowfield. The annual temperature wave, if accompanied by the rapid accumulation of snow, causes considerably lower temperatures than otherwise. A diffusivity which varies slowly with depth may be treated approximately as equivalent to a theoretical fictitious velocity of accumulation.

4. An Automatically-Recording Photometer for the Measurement of Light Scattered by Liquid Droplets. E. P. CLANCY, *Mount Holyoke College.*—An experimental study is being made of the scattering of light by liquid droplets whose diameters lie within the range to which the Mie theory of scattering applies.