—first, because of the large values for the separation factor; and second, because of the high speed with which equilibrium between diffusion and sedimentation is apparently established. It is hoped that a test of this method can soon be made.

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Regularities in the Third Spectrum of Thorium

R. J. Lang
Department of Physics, University of Alberta, Edmonton, Canada

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The thorium spectrum is very rich in lines and extends into the far ultraviolet beyond 200A. The lines have been classified into II, III and IV as far as 1500A by means of the pole effect. A condensed spark in air and in nitrogen between metallic electrodes was used. The Th III spectrum lies on the short side of 3500A with most of its strong lines between 3000 and 2200A. Twenty-four energy levels are given.

A CONDENSED spark in air or nitrogen between electrodes of metallic thorium connected to a 30,000-volt transformer was employed to separate the lines of the thorium spectrum into the three spectra II, III and IV. In a previous report[1] the main lines of Th IV were classified into the usual single-electron doublet system with the very large ^2P interval of 12,818 cm^{-1}. (See note at end.) These Th IV lines are scattered throughout the spectrum from 2694 to 847A and are easily distinguished by the pole effect, in the region down to 1500A where it can be applied, by the fact that while the lines are very intense they are completely broken, while Th II lines are not affected at all, or very slightly, and those of Th III are intermediate, i.e., they are markedly constricted but not entirely broken. Of course there are gradations in any one spectrum and in the region between 3500 and 3000A, where there is complete overlapping of II and III, it is not always possible to distinguish them. The most of the main lines of Th III appear to lie between 3000 and 2200A but it seems likely that some of the several thousand lines in the vacuum spark below 1000A will belong to this spectrum. There are many strong lines in the region between 600 and 400A.

Owing to the structure of the IV spectrum, in which the deepest term is a doublet D arising from a single (d) electron, it is to be expected that the III spectrum will have a structure similar to Zr III[2] and not to Ce III.[3] The intervals of the (dp) terms are hopelessly irregular already in Zr III and the intensity rules in the $(ds)^3D-(dp)^3P^3D^3F$ multiplets in Zr III and Cb IV[4] are so badly obeyed that sometimes the satellites have greater intensity than the main diagonal lines. Consequently an attempt was made to find intervals which might be suitable for the $(ds)^3D$ and the (deepest) $(d^2)^3F$ terms.

Table I shows twelve even and twelve odd energy values and the lines upon which these are based. Many of these lines are the strongest in the spectrum.

During the progress of this work two reports on thorium spectra appeared.[5,6] Through the

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[2] C. C. Kiess and R. J. Lang, Nat. Bur. Stand. J. Res. **5**, 305 (1930).
[3] H. N. Russell, R. B. King, and R. J. Lang, Phys. Rev. **52**, 456 (1937).
[4] R. J. Lang, *Zeeman Verhandelingen* (Martinus Nijhoff, Hague, 1935), p. 44.
[5] Mark Fred, Astrophys. J. **87**, 176 (1938).
[6] T. L. de Bruin and J. N. Lier, Proc. K. Akad. Amsterdam **41**, 956 (1938).

TABLE I. *Energy levels in the spectrum of* Th III.

	0.00	620.39	1,467.79	3,119.97	4.691.19	4.748.69	4,947.58	5,897.34	6,137.31	6,778.92	6,828.09	10,018.70
47,934.14					65 2,311.51 43,248.48				120 2,391.50 41,801.95	15 2,428.80 41,160.05	160 2,431.69 41,111.10	
46,108.18						3 2,417.08 41,359.74	15 2,428.80 41,160.05		120 2,501.07 39,970.87	50 2,541.86 39,329.42	110 2,545.07 39,279.92	
45,923.68	10 2,176.83 45,923.82	110 2,206.63 45,303.79		130 2,335.51 42,804.13	40 2,424.57 41,231.94	160 2,427.95 41,174.51		60 2,497.56 40,027.01	100 2,512.69 39,786.01			40 2,784.34 35,904.62
45,269.16					160 2,463.65 40,577.88				90 2,554.70 39,131.75	110 2,597.28 38,490.29	90 2,600.60 38,441.20	
43,623.50	120 2,291.63 43,623.64	40 2,324.69 43,003.26	140 2,371.43 42,155.80		100 2,567.81 38,932.11	120 2,571.61 38,874.57			50 2,666.84 37,486.41			50 2,974.92 33,604.61
41,007.62		100 2,475.29 40,387.07	40 2,528.33 39,539.99	60 2,638.60 37,887.64								
40,949.90					40 2,757.15 36,258.68	30 2,761.52 36,201.32	10 2,776.79 36,002.30		40 2,871.70 34,812.38	50 2,925.61 34,170.99		60 3,232.07 30,931.31
40,409.12	160 2,473.94 40,409.12	50 2,512.52 39,788.78		100 2,680.95 37,289.18				90 2,896.72 34,511.69				
40,032.42	60 2,497.21 40,032.59	100 2,536.54 39,411.94		70 2,708.31 36,912.51				70 2,928.70 34,134.95				
37,217.41	125 2,686.13 37,217.32	20 2,731.66 36,597.02				40 3,078.98 32,468.90	100 3,097.97 32,269.82		70 3,216.58 31,080.03			
37,068.46							40 3,112.35 32,120.80		60 3,232.07 30,931.31	70 3,300.53 30,289.45		
33,224.20		40 3,066.24 32,603.87	70 3,148.05 31,756.51	8 3,320.86 30,104.07								

kindness of the author of the first paper and the Ryerson Laboratory a set of plates of thorium spectra was made available as well as a long list of measurements in the spark spectrum made by Mr. Ference. The author's appreciation is hereby expressed.

NOTE ON THE SPECTRUM Th IV

In the report on this spectrum a term designated as X was given. It now seems clear that this is part of the $7P-7D$ multiplet as follows:

$7P_2-7D_2$	2146.93	(20)	46,563.4	
				1806.1
$7P_2-7D_3$	2066.77	(100)	48,369.5	
				12,817.2
$7P_1-7D_2$	1684.05	(50)	59,380.6	

The multiplet given tentatively as $5F-5G$ has not been confirmed and probably has no reality.

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