distances from lightning flashes, as he found a preponderance of field changes in the opposite direction; but this difference is most probably due to the fact that a thundercloud is bi-polar, as Mr. Wilson suggested, in which case the sign of the electric field change in regions near the thundercloud is determined almost solely by the sign of the lower charge dissipated in the discharge.

E. V. APPLETON.
R. A. WATSON WATT.
J. F. HERD.

January 31.

The Spectrum of Manganese.

IN an interesting paper, M. A. Catalán (Phil. Trans., A 223, 1922, p. 127) has found series and terms in the manganese arc spectrum. He has also found "Multiplets," which are combinations of multiple terms.

With the help of the theory of A. Landé (*Zeit. f. Phys.* 15, pp. 189 and 206), E. Back has succeeded in determining the types of the greater part of these multiple terms. It is also possible to calculate the *values* of these terms.

Considering Table IV. on p. 159 of Catalán's work, we see from the triplet separations that the first four multiplets are combinations involving the known terms P and (P+C). By these we can easily get the two new quintuple terms:

$D_1' = 42885{\cdot}2$		$D_1''' = 12730{\cdot}2$	
	229·7		4·8
$D_2' = 655{\cdot}5$		$D_2''' = 725{\cdot}4$	
	169·5		3·5
$D_3' = 486{\cdot}0$		$D_3''' = 721{\cdot}9$	
	116·9		2·5
$D_4' = 369{\cdot}1$		$D_4''' = 719{\cdot}4$	
	68·8		1·4
$D_5' = 300{\cdot}5$		$D_5''' = 718{\cdot}0$	

We see that they are "inverted" terms, *i.e.* $D_1 > D_2 > \ldots$, as Sommerfeld has already remarked (*Ann. der Phys.* 70, p. 48).

Fortunately the remaining five "Multiplets," according to their quintuplet separations, are combinations with the above calculated D′-terms, and we can easily calculate the other terms. The nine multiplets may then be designated:

I.	(P+C) − D′′′	V.	D′ − P″
II.	P − D′′′	VI.	D′ − D″
III.	D′ − P	VII.	D′ − D′′′
IV.	D′ − (P+C)	VIII.	D′ − F
		IX.	D′ − D^{IV}

The symbols P, (P+C), P″, D′, D″, F are confirmed by the work of Back. The remaining ones can be denominated with considerable certainty as P′′′, D′′′, D^{IV}. The new terms are all inverted. They are:

$P_1'' = 14943{\cdot}6$			$P_1''' = 10049{\cdot}4$		
	162·2			124·3	
$P_2'' = 781{\cdot}4$			$P_2''' = 9925{\cdot}2$		
	103·0			86·7	
$P_3'' = 678{\cdot}3$			$P_3''' = 9838{\cdot}5$		
$D_1'' = 18148{\cdot}1$		$D_1^{IV} = 11769{\cdot}6$		$F_1 = 16624{\cdot}2$	
	143·2		58·0		115·3
$D_2'' = 004{\cdot}9$		$D_2^{IV} = 711{\cdot}6$		$F_2 = 508{\cdot}9$	
	121·1		44·9		95·5
$D_3'' = 17883{\cdot}8$		$D_3^{IV} = 666{\cdot}7$		$F_3 = 413{\cdot}4$	
	89·8		30·1		71·4
$D_4'' = 794{\cdot}0$		$D_4^{IV} = 636{\cdot}6$		$F_4 = 342{\cdot}0$	
	55·1		17·1		49·0
$D_5'' = 738{\cdot}9$		$D_5^{IV} = 619{\cdot}5$		$F_5 = 293{\cdot}0$	
					28·5
				$F_6 = 264{\cdot}5$	

It is interesting to note that the new term D′ is greater than the greatest known P-term; it should therefore represent a metastable state of the atom. (Like the greatest d-terms in Ca^+, Sr^+, Ba^+, see, *e.g.*, the figs. of Bohr, *Ann. der Phys.* 71, p. 287.) So long as all the terms of manganese are not known, this is of course not absolutely certain.

It should be of interest to seek for still other combinations of these new terms.

S. GOUDSMIT.

University of Leyden,
Instituut voor
Theoretische Natuurkunde.

Monazite Sands and other Sources of Thoria.

THE issue of NATURE for November 10, 1923, contains an article entitled "The Imperial Institute and the Development of Overseas Resources," in which, as a claim to the high value of the work of the Institute, the following statement is made: "The discovery of the monazite sands of Ceylon has destroyed the former German monopoly based on Brazilian material."

According to the Annual Colonial Reports on Ceylon, the treatment of the monazite sands of the island commenced in 1918; and from these reports and other sources it is estimated that the total production of refined monazite sand in Ceylon from 1918 to the end of 1922, when the works were closed down, was 235 tons only. During the same years, the Travancore deposits of the South Indian Coast have yielded 7166 tons; the total from 1914 to the end of 1922 was 12,711 tons of refined monazite sand.

It may be left to the reader to judge as to what extent the Imperial Institute and the development of the deposits of Ceylon were responsible for the destruction of the German monopoly. The following table from "The Mineral Industry during 1922," page 485, will help him:

WORLD'S PRODUCTION OF MONAZITE SAND.
(In metric tons.)

	Brazil (*a*).	United States.	Travancore, India.	Ceylon.
1910	5345	44·3	Nil	..
1911	3627	1·6	819	..
1912	3344	0·6	1135	..
1913	1415	Nil	1234	..
1914	599	Nil	1185	..
1915	439	16·1	1108	..
1916	Nil	16·5	1292	..
1917	1136	34·7	1940	..
1918	499	(*b*)	2117	20
1919	146	(*b*)	2057	40
1920	1153	(*b*)	1667	70
1921	..	(*b*)	1280	70 (*c*)

(*a*) Exports. (*b*) Less than three producers, no statistics published. (*c*) Estimated.

E. H. PASCOE,
Director.
Geological Survey of India, December 11.

THE apparent inconsistency between the statistics quoted by Dr. Pascoe and the statement to which he refers can be explained only by fuller reference to the contributions of the Imperial Institute to the development of the rare earth industry. It should be mentioned that in accordance with general usage, as, for example, in the annual article in "Mineral Industry," monazite sand was used to cover other sources of thoria. In 1903–4 the present writer was endeavouring to secure an output for the monazite of another