The Third Spark Spectrum of Krypton.

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Abstract.

In a previous paper on "The Second Spark Spectrum of Krypton," a long list of new lines of Krypton in the extreme ultra-violet, was published by the present author. In this paper, some of these lines have been classified and are believed to be due to the different transitions of Kr^{+++}. Only quartets have however, been discovered, and it is felt that more accurate measurement of lines in this region, preferably with a vacuum spectrograph, is necessary to identify doublets and inter-combination between quartets and doublets.

In a previous paper,[1] the second spark spectrum of Krypton was partially analysed. The quintets were completely determined and an indication of the triplets and singlets was given. In the same paper, a long list of new lines of Krypton in the extreme ultra-violet was also published. It would appear from the list that some very strong lines, *viz.*, 42475·1 (10) and 40560·3 (9) were observed in the region of 41000. Although the lines of Kr^{++}, due to the transition $3N_2(O_2 \leftarrow O_3)$ had been located in this region, none of these intense lines fitted in with the scheme of analysis of this transition. It was believed therefore, that these lines might owe their origin to the spectrum of Kr^{+++} due to the transition $2N_2(O \leftarrow O_2)$. Further, by extrapolation by the method

[1] Ind. J. Phys., 5, 385, 1930.

of horizontal comparison, it was found that the fundamental lines of Kr^{+++} due to this transition, would lie in this region. A short note in this connection, was published by the author in " Nature " of Feb. 8, 1930.

The arrangement of electrons in an atom of Kr^{+++} may be graphically represented, following Prof. M. N. Saha, in the manner shown below :—

K_1						
2						
L_1	L_2					
2	6					
	M_1	M_2	M_3			
	2	6	10			
		N_1	N_2	N_3	N_4	
		2	3			
			O_1	O_2	O_3	
				P_1	P_2	

The most stable structure of a trebly ionised Krypton atom, is that when all the three valence electrons are in N_2 level. Other less stable configurations are obtained by placing 2 electrons in N_2 and the third one in any of the remaining orbits O_1, P_1, O_2, O_3, etc.

The terms that these different electronic configurations give rise to have been calculated on the principles enunciated by Pauli, Heisenberg, and Hund. They are given in Table I. We shall use the notation proposed by A. Fowler.[2]

TABLE I.

Electrons outside rare gas shell.	Configurations.	Prefix Adopted.	Terms. (Only quartet terms are given).		
$4s^2.\ 4p^3.\ 5s$	$2N_2O_1$	$5s$	^4P		
$4s^2.\ 4p^3.\ 6s$	$2N_2P_1$	$6s$			
$4s^2.\ 4p^2.\ 5p$	$2N_2O_2$	$5p$	^4D	^4P	^4S
$4s^2.\ 4p^3.\ 5d$	$2N_2O_3$	$5d$	^4F	^4D	^4P
$4s^2.\ 4p^2.\ 4d$	$2N_2N_3$	$4d$			

[2] Proc. Roy. Soc., *117*, 317, 1928.

The following is the scheme of predicted regions in which the lines of Kr^{+++} would lie. This has been obtained by comparison with the analysis of the analogous spectrum of Br^{++}, as obtained by Mr. S. C. Deb.[3]

TABLE II.

	$2N_2O_1$	$2N_2P_1$	$2N_2O_3$		
	^4P	^4P	^4F	^4D	^4P
$2N_2O_2 \rightarrow {}^4D$	41000	43000	46000	49000	52000
^4P	43000	40000	43000	46000	49000
^4S	46000	37000	40000	43000	46000

The analysis of the spectrum of Kr^{+++} was attempted in the regions predicted above, and as a result the following multiplets have been discovered.

The Multiplets.

$2N_2O_1 \rightarrow$		$5s^4P_1$.	579·5.	$5s^4P_2$.	838·2.	$5s^4P_3$.
$2N_2O_2 \rightarrow$	$5p^4D_1$	38646·2(1)		39225·7(1)		...
	477·4					
	$5p^4D_2$	39125·2(4)		39703·3(2)		40542·2(2)
	857·6					
	$5p^4D_3$	...		40560·3(9)		41397·7(5)
	1077·8					
	$5p^4D_4$	...		...		42475·1(10)
	$5p^4P_1$	41093·8(0)		41669·7(1)		...
	651·4					
	$5p^4P_2$	41744·1(0)		42322·1(1)		43160·5(3)
	298·2					
	$5p^4P_3$	...		42620·3(2)		43459·3(1)
	$5p^4S_1$	46605·3(2)		47183·5(4)		48021·8(6)

[3] Proc. Roy. Soc., 127, 197, 1930.

$2N_2P_1 \rightarrow$		$6s^4P_1$.	960·4.	$6s^4P_2$.	1078·9.	$6s^4P_3$.
$2N_2O_2 \rightarrow$	$5p^4D_1$	44871·4(2)		43910·2(1)		...
	477·4					
	$5p^4D_2$	44393·3(0)		43434·2(1)		42354·0(1)
	857·6					
	$5p^4D_3$	...		42575·3(0)		41497·2(1)
	1077·7					
	$5p^4D_4$	...		...		40419·5(1)
	$5p^4P_1$	40735·8(1)		39774·7(0)		...
	651·4					
	$5p^4P_2$	?		?		38043·9(1)
	298·2					
	$5p^4P_3$	...		38826·8(1)		37746·6(4)
	$5p^4S_1$	37358·2(2)		36398·5(1)		35320·0(1)

$2N_2O_3 \rightarrow$		$5d^4F_2$.	468·5.	$5d^4F_3$.	578·8.	$5d^4F_4$.
$2N_2O_2 \rightarrow$	$5p^4P_1$	41682·3(1)		...		...
	651·4					
	$5p^4P_2$	41030·2(1)		2		...
	298·2					
	$5p^4P_3$	40732·1(0)		41201·2(3)		41779·4(4)
	$5p^4S_2$	39718·4(2)		40186·3(2)		40765·8(5)

It would appear from Table II that the remaining lines of Kr^{+++} due to the transition $2N_2(O_2 \leftarrow O_3)$ are expected to lie in the region 46000-52000. Most of the lines as obtained on the plate (*vide*, the paper on " The Second Spark Spectrum of Krypton "), are extremely faint in this region, and as a

result the measurement has not been sufficiently accurate to enable one to classify these lines. It is desirable that this end of the spectrum should again be studied under more favourable conditions, preferably with the aid of a vacuum spectrograph.

In conclusion, I desire to offer my sincere gratitude to Dr. M. N. Saha, D.Sc., F.R.S., who first suggested to me that these lines might be due to Kr^{+++}.