Physics. — *The magnetic separation in the spectrum of ionised Krypton (Kr II).* By C. J. BAKKER and P. ZEEMAN.

(Communicated at the meeting of May 25. 1929.)

1. *Introduction.*

After the discovery of Argon by Lord RAYLEIGH and RAMSAY (1895) RAMSAY and TRAVERS (1898) investigated more exactly the rests, which remain after evaporation of fluid air. After purifying from O_2 and N_2 those rests, brought again in gasform, gave when they were investigated spectroscopically besides the Argon lines a number of very strong, unknown lines. The gas, to which those lines belong was called *Krypton.*

RAMSAY and TRAVERS have only given orientative measurements of the Krypton lines, but after them many investigators have occupied themselves with the investigation of the spectroscopic behaviour and the measuring of wavelengths [1]). RUNGE (1899) was the first, who observed that Krypton just as CROOKES discovered with Argon can give two different spectra, dependent on the discharge method. Condensed discharges give rise to a spectrum rich in lines, called by BALY [2]) the second spectrum and which according to the theory of BOHR, arises from ionised states of the Krypton atom.

L. BLOCH, E. BLOCH and G. DÉJARDIN [3]) investigated the spectra of the ionised inert gases by means of electrodeless discharges, while ABBINK and DORGELO [4]) performed investigations in the far ultra violet by means of a vacuum spectrograph. With those wavelengths measurements KICHLU [5]) has succeeded in giving a partial analysis of the spectrum of ionised Krypton (*Kr II*).

In this paper we give a first communication on the investigation of the magnetic separation in the spectrum of ionised Krypton (Kr II). This investigation is directly related to the investigations on the other ionised inert gases (*Ne II* and *Ar II*) performed in this laboratory [6]).

---

[1]) See H. KAYSER. Handbuch der Spectroscopie. Band **5**.

[2]) E. C. C. BALY: Phil. Transact. A **202**, 183, 1903.

[3]) L. BLOCH, E. BLOCH and G. DÉJARDIN: Annales de Physique 2, 462, 1924.

[4]) J. H. ABBINK and H. B. DORGELO: Zeitschr. f. Phys. **47**, 221, 1928; Physica **7**, 343, 1927.

[5]) P. K. KICHLU: Proc. Royal Soc. London **120** A, 643, 1928.

[6]) Concerning *NeII* see:

T. L. DE BRUIN: Versl. Kon. Ak. Amsterdam **36**, 502, 1927 and **37**, 340, 1928; Proceedings **31**, 2, 1928 and **31**, 593, 1928; Zeitschr. f. Phys. **44**, 157, 1927 and **46**, 856, 1928.

C. J. BAKKER: Versl. Kon. Ak. Amsterdam **37**, 890, 1928; Proceedings **32**, 515, 1929.

Concerning *ArII* see:

T. L. DE BRUIN: Versl. Kon. Ak. Amsterdam **37**, 340, 1928 and **37**, 553, 1928; Proc. **31**, 593, 1928 and **31**, 771, 1928; Zeitschr. f. Phys. **48**, 62, 1928 and **51**, 108, 1928.

C. J. BAKKER, T. L. DE BRUIN and P. ZEEMAN: Versl. Kon. Ak. Amsterdam **37**, 562. 1928 and **37**, 840, 1928; Proc. **31**, 780, 1928; Zeitschr. f. Phys. **51**, 114, 1928 and **52**, 299, 1928.

2. *Theoretical termscheme of Kr II.*

According to the theory of the periodic system of BOHR—SOMMERFELD the simply ionised Krypton atom possesses in his unexcited state 5 electrons in a $4p$ orbit. According to considerations of PAULI and WENTZEL such a configuration will give the same deepest lying term arising from the binding of one electron in a $4p$ orbit, and this will be an "inverted" ^2P term.

The other terms can be deduced theoretically by binding to the core successively a $4d$, $5s$, $5p$ ...... electron and by using the structure rules of HEISENBERG, LANDÉ and HUND.

Table 1 gives the terms deduced for the basic term ^3P. Possibly there are also terms arising from the metastable states ^1S and ^1D.

TABLE 1. Krypton II (deep terms).

Electronic configuration											Terms (basic term ^{3}P)	
1s	2s	2p	3s	3p	3d	4s	4p	4d	5s	5p	Quartet	Doublet
2	2	6	2	6	10	2	5					P
2	2	6	2	6	10	2	4	1			F D P	F D P
									1		P	P
										1	D P S	D P S

3. *Experimental terms* 1)

In this communication we will give the magnetic separations of spectrallines, which are combinations of the terms arising from the $5s$ and $5p$ electron. Almost all those terms are known by the analysis of the spectrum by KICHLU (loc. cit.) ; it seems only necessary on account of the magnetic separation to change somewhat the interpretation of the $5p$ terms of KICHLU. Table 2 includes in the first column the relative termvalues, in the third column the interpretation of KICHLU and in the fourth those of the authors. Figure 1 shows a survey of the situation of the analogous p-terms for ionised Neon, Argon and Krypton, namely of the terms arising from the $3p$-electron for *Ne II*, from the $4p$-electron for *Ar II* and from the $5p$-electron for *Kr II*. In this figure the distance $^4P_3$—$^4P_1$ is choosen as unity of drawing for getting a clear figure.

The term 77047.0 is classified by KICHLU as $^4S_2$ on account of the combinations with $5s$ $^4P_3$, $^4P_2$ and $^4P_1$. However the magnetic separations of the combinations with the terms $5s$ $^4P_3$ and $5s$ $^4P_2$ do not answer the expectation ; it seems certain that a coincidence of 2 terms exists here.

The combination of this term 77047.0 with the term $5s$ $^4P_3$ is one of the strongest lines of the spectrum and this line splits up in the magnetic

---

1) For typographical simplicity the inner quantum number j is everywhere replaced by the whole number $j + {}^1/_2$.

field in a strong "Pseudo-triplet" as one must expect for a combination $^4P_3$—$^4D_4$. Figure 1 shows that the termdifference $5p\ ^4D_4$—$5p\ ^4D_3$ for *Kr II* is very small.

The term 70834.2 has surely the inner quantumnumber $j = 2$ and is interpreted as $^2D_2$.

The term 73726.4 is interpreted as $5p\ ^2P_1$, however the combination with $5s\ ^2P_1$ does not occur in the list of wavelengths of BLOCH c.s. [1]). At the same time it will appear that this term shows a very strong anomalous *g*-value.

TABLE 2.

Relative Termvalues	Term-difference	KICHLU	Authors	*g*-values	
				LANDÉ	Obs.
100000.0	2263.8	b $^4P_3$	5 s $^4P_3$	1.60	1.60
97736.2	2511.0	b $^4P_2$	5 s $^4P_2$	1.73	1.54
95225.2		b $^4P_1$	5 s $^4P_1$	2.67	2.64
94353.7	2527.6	b $^2P_2$	5 s $^2P_2$	1.33	1.52
91826.1		b $^2P_1$	5 s $^2P_1$	0.67	0.70
78904.3	362.8	c $^4P_3$	5 p $^4P_3$	1.60	1.60
78541.5	884.8	c $^4P_2$	5 p $^4P_2$	1.73	1.67
77656.7		c $^4P_1$	5 p $^4P_1$	2.67	—
77047.0	288.1	c $^4S_2$	5 p $^4D_4$	1.43	1.43
76758.9	2310.5	c $^4D_3$	5 p $^4D_3$	1.37	1.23
74448.4	1781.7	c $^4D_2$	5 p $^4D_2$	1.20	1.26
72666.7		—	5 p $^4D_1$	0.00	0.00
72710.8	1876.6	c $^2D_3$	5 p $^2D_3$	1.20	1.34
70834.2		c $^2P_1$	5 p $^2D_2$	0.80	1.33
72692.6	— 1033.8	c $^2P_2$	5 p $^2P_2$	1.33	1.26
73726.4		—	5 p $^2P_1$	0.67	1.78
71107.3		c $^2D_2$	5 p $^4S_2$	2.00	1.54
70466.3		c $^2S_1$	5 p $^2S_1$	2.00	1.50

---

[1]) Calculated $5s\ ^2P_1$—$5p\ ^2P_1$ $\nu = 18099.7$. There is present a line with $\nu = 18101.1$. This difference seems too large.

It is remarkable that the combination $5s\,^2P_1$—$5p\,^2P_2$ ($\lambda = 5224.98$ $\nu = 19133.5$) is not present in the list of wavelengths of BLOCH c.s.

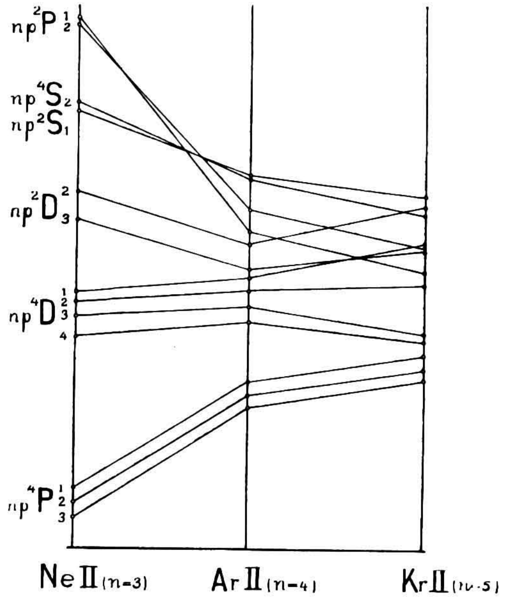


Fig. 1.

Table 3 includes the combinations and intercombinations of the terms arising from the 5s and 5p electron. The wavelengths and intensities are taken from L. BLOCH, E. BLOCH and G. DÉJARDIN, l.c.

4. *Experimental part.*

Figure 2 shows the mounting that has been used for the investigation of the magnetic separation. The *magnet* is a large water cooled WEISS-electromagnet, made by the engine factory "Oerlikon" (Zürich). It is operated on a current of 100 Ampères and with the used distance of the endplanes of the poles the magnetic field amounts to about 41000 Gauss.

The poles of the magnet are enclosed by a copper vacuum box [1]). The conical plugs to which the electrodes are attached, are made of ebonite and ground to fit into openings into the box. The gas discharge passes between two circular aluminium plates just covering the pole tips of the magnet. The discharge passes thus parallel to the magnetic field and is concentrated with well choosen gas pressure entirely to the central part of the field, which increases the intensity of the light very much. Just as for Neon and Argon l.c. we used an uncondensed alternating current of high potential furnished by a transformer that operated on ½ K.W.

Before the expensive Krypton was led into the vacuum space, electrolytically produced Hydrogen was led during many hours through the

---

[1]) See BACK—LANDÉ: ZEEMAN-effekt und Multipletstruktur Springer, Berlin, 1925.

TABLE 3.

Int.	λ I. Å.	$\nu_{vacuüm}$	Termcombination	Int.	λ I. Å.	$\nu_{vacuüm}$	Termcombination
1	5752.97	17377.5	5 s $^{2}P_{1}$ — 5 p $^{4}D_{2}$	12	4355.50	22953.0	5 s $^{4}P_{3}$ — 5 p $^{4}D_{4}$
2	5690.34	17568.8	5 s $^{4}P_{1}$ — 5 p $^{4}P_{1}$	4	4301.55	23240.9	5 s $^{4}P_{3}$ — 5 p $^{4}D_{3}$
4	5681.93	17594.8	5 s $^{2}P_{2}$ — 5 p $^{4}D_{3}$	4	4300.51	23246.5	5 s $^{2}P_{2}$ — 5 p $^{4}S_{2}$
3	5308.66	18831.9	5 s $^{4}P_{2}$ — 5 p $^{4}P_{3}$	6	4292.94	23287.5	5 s $^{4}P_{2}$ — 5 p $^{4}D_{2}$
5	5208.33	19194.7	5 s $^{4}P_{2}$ — 5 p $^{4}P_{2}$	3	4250.60	23519.5	5 s $^{2}P_{2}$ — 5 p $^{2}D_{2}$
3	5022.39	19905.3	5 s $^{2}P_{2}$ — 5 p $^{4}D_{2}$	2	4185.13	23887.4	5 s $^{2}P_{2}$ — 5 p $^{2}S_{1}$
1	4978.82	20079.5	5 s $^{4}P_{2}$ — 5 p $^{4}P_{1}$	5	4145.13	24117.9	5 s $^{4}P_{1}$ — 5 p $^{4}S_{2}$
5	4846.58	20627.4	5 s $^{2}P_{2}$ — 5 p $^{2}P_{1}$	5	4098.74	24390.9	5 s $^{4}P_{1}$ — 5 p $^{2}D_{2}$
3	4825.19	20718.8	5 s $^{2}P_{1}$ — 5 p $^{4}S_{2}$	4	4037.81	24758.9	5 s $^{4}P_{1}$ — 5 p $^{2}S_{1}$
3	4811.73	20776.8	5 s $^{4}P_{1}$ — 5 p $^{4}D_{2}$	6	3994.83	25025.3	5 s $^{4}P_{2}$ — 5 p $^{2}D_{3}$
5	4765.72	20977.3	5 s $^{4}P_{2}$ — 5 p $^{4}D_{3}$	6	3991.93	25043.5	5 s $^{4}P_{2}$ — 5 p $^{2}P_{2}$
3	4762.42	20991.9	5 s $^{2}P_{1}$ — 5 p $^{2}D_{2}$	2	3987.78	25069.6	5 s $^{4}P_{2}$ — 5 p $^{4}D_{1}$
7	4738.98	21095.7	5 s $^{4}P_{3}$ — 5 p $^{4}P_{3}$	5	3912.54	25551.6	5 s $^{4}P_{3}$ — 5 p $^{4}D_{2}$
4	4680.39	21359.8	5 s $^{2}P_{1}$ — 5 p $^{2}S_{1}$	5	3754.20	26629.3	5 s $^{4}P_{2}$ — 5 p $^{4}S_{2}$
5	4658.86	21458.5	5 s $^{4}P_{3}$ — 5 p $^{4}P_{2}$	0	3666.00	27269.9	5 s $^{4}P_{2}$ — 5 p $^{2}S_{1}$
2	4650.15	21498.7	5 s $^{4}P_{1}$ — 5 p $^{2}P_{1}$	2	3663.42	27289.1	5 s $^{4}P_{3}$ — 5 p $^{2}D_{3}$
5	4619.13	21643.1	5 s $^{2}P_{2}$ — 5 p $^{2}D_{3}$	1	3661.00	27307.2	5 s $^{4}P_{3}$ — 5 p $^{2}P_{2}$
3	4615.28	21661.1	5 s $^{2}P_{2}$ — 5 p $^{2}P_{2}$	4	3460.09	28892.7	5 s $^{4}P_{3}$ — 5 p $^{4}S_{2}$
5	4436.81	22532.4	5 s $^{4}P_{1}$ — 5 p $^{2}P_{2}$	3	3427.70	29165.7	5 s $^{4}P_{3}$ — 5 p $^{2}D_{2}$
5	4431.68	22558.5	5 s $^{4}P_{1}$ — 5 p $^{4}D_{1}$				

box while regularly discharges were switched on for removing as much as possible the impurities, sticked on the magnetic poles and on the inside of the box. After that the Hydrogen passage was finished and yet pumped for an hour, during which time the vacuum is so high, that with low voltage no discharge passes. There after the Krypton gas was led into the box and the spectrum of one filling remained satisfactorily constant during the time of exposure that varied between 4 and 5 hours. After the exposure the gas could be collected in a large vacuum reservoir.

The exposures are made by means of the *stigmatic grating mounting* 1) of the laboratory. The slit *S* is placed in the focus of a concave mirror *Sp.*

---

1) RUNGE and PASCHEN: Wied. Ann. **61**, 641, 1897. P. ZEEMAN used this mounting since 1900 for many investigations.

MEGGERS and BURNS: Sc. Pap. Bur. of Standards N⁰. 441, Vol. **18**, 1922.

The mirror sends a parallel beam to the large concave ROWLAND grating *T*. The photographs C are made in the 2nd order, which is a brillant order of the used grating. In the neighbourhood of the normal of the grating where the photographic plates are placed the dispersion is about 2.4 Å. The grating used has 14438 lines to the inch and a width of 5 inches. (Originally 6 inch but one inch is covered on account of disturbances.)

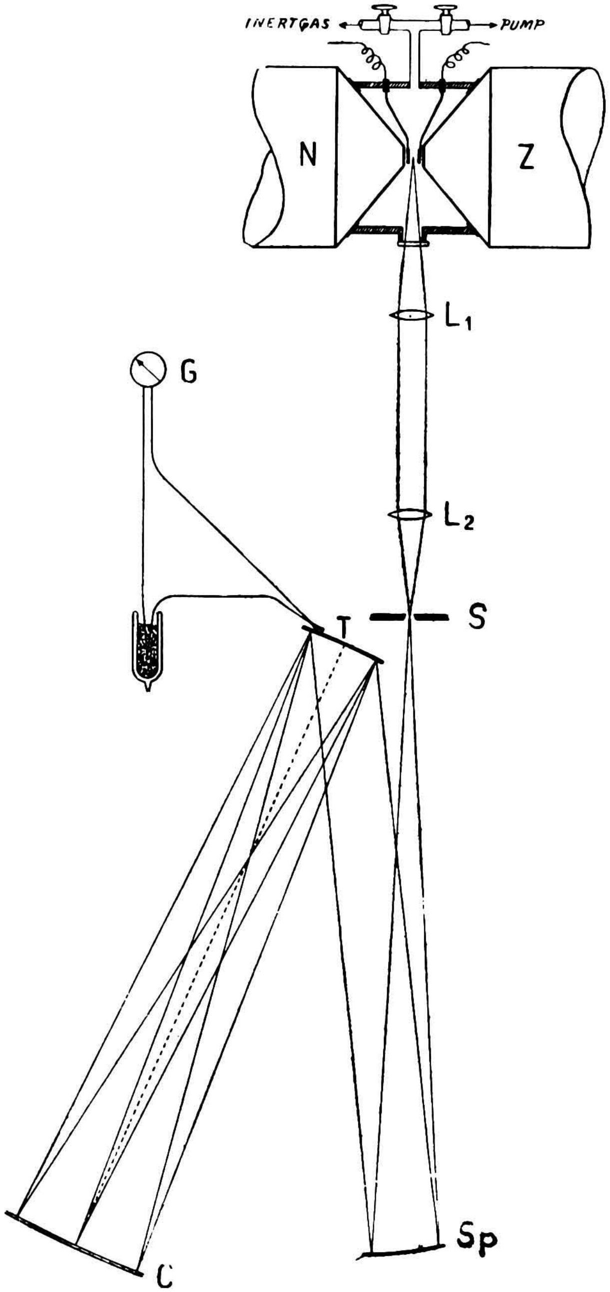


Fig. 2.

Grating mounting and magnet are placed upon a large bloc made of concrete (weight 250.000 K.G.) free of vibrations.

In the grating room *the temperature* can be hold *constant* till upon 0°.1 by means of a automatically regulating ether thermometer which. via a relais breaks or cuts in the electric current in heating spirals [1]). The grating does not follow those temperature swingings of 0°,1 and remains constant to 0°.01 during the exposures. This is controlled by means of a thermo couple and galvanometer *G* with mirror reading. One pole of the thermo couple is put against the backside of the grating. (See figure 2.)

We have measured the *intensity* of the *magnetic* field in the first place with the aid of the magnetic separations of the well known *Zn*-triplet 4811, 4722 and 4680. After a Krypton exposure the electrodes for the gas discharge were therefore replaced by a so called "vacuum trembleur" constructed in this laboratory by VAN DER MARK [2]) provided with one *Zn*-electrode and one Tungsten electrode.

In consequence of a weak sputtering of the Aluminium electrodes used for the gas discharge the first lines of the principal series of the *Al* spectrum $\lambda = 3961.5$ and 3944 appeared on our plates. The magnetic separations of those lines are fine and can be used for intensity measurement of the field.

5. *The magnetic separation. Normal and anomalous g-values.*

According to the theory of LANDÉ [3]) the magnetic separation of a classified spectral line, arising from the combination between two known terms, can be calculated. The distances of the magnetic components to the place of the original line are given by the equation :

$$\triangle \nu = (m'g' - m''g'') \, . \, o$$

in which : $o = \frac{e}{m} \cdot \frac{H}{4\pi c}$ is the normal splitting distance and unit of notation for magnetic separations.

m is the magnetic quantum number, which has $2j + 1$ values for a term with the inner quantum number j namely $m = j, \; j - 1, \; \ldots\ldots \; -j$. Each of these values marks a magnetic sublevel., while only levels with $\triangle m = 0$ or ± 1 combine. ($\triangle m = 0$, π-component, $\triangle m = \pm 1$ σ component).

The factor g in the equation is the well known splitting factor of LANDÉ, which can be calculated directly with the aid of the quantum numbers of

---

[1]) See GEHRCKE: Handb. d. Physik, Optik, Band **2**, zweite Hälfte, erster Teil. P. ZEEMAN and T. L. DE BRUIN: Magnetische Zerlegung der Spektrallinien, p. 605.

[2]) As preceeding note p. 608.

S. GOUDSMIT, J. V. D. MARK and P. ZEEMAN: Versl. Kon. Ak. Amsterdam **33**, 977, 1924; Proceedings **28**, 127, 1925.

[3]) E, BACK und A. LANDÉ: ZEEMAN-effekt und Multipletstruktur.

a term. When the coupling scheme of RUSSELL—SAUNDERS holds the g-value of a term is given by the formula:

$$g = 1 + \frac{j(j+1) + s(s+1) - l(l+1)}{2j(j+1)}.$$

Here is: j = inner quantum number, s = rotational quantum number (spin) l = azimuthal quantum number.

The coupling scheme of RUSSELL and SAUNDERS is symbolically given by: $\{ (s, s_2)\ (l_1\, l_2) \} = (s\, l) = j$ in which s_1 and l_1 belong to the atomic core and s_2 and l_2 to the optical electron.

On account of further theoretical considerations of LANDÉ one can expect deviations from those g-values will appear in the spectra of the inert gases. (for the arc spectra as well as for the ionised spectra) BACK [1]) was the first who checked this in the arc spectrum of Neon (*Ne I*), while the experimental investigation of the magnetic separation of ionised Neon (*Ne II*) and ionised Argon (*Ar II*) and now also of ionised Krypton (*Kr II*) has learned that there appear so called "anomalous" *g-values* in these spectra.

According to GOUDSMIT and UHLENBECK [2]) one can yet calculate g-values for other coupling schemes:

$$\{(s_1\, l_1)\,(s_2\, l_2)\} = (j_1\, j_2) = j$$
$$[\{(s_1\, l_1)\, s_2\}\ l_2] = \{(j_1\, s_2)\, l_2\} = (s'\, l_2) = j$$
$$[\{(s_1\, l_1)\, l_2\}\ s_2] = \{(j_1\, l_2)\, s_2\} = (l'\, s_2) = j.$$

None of these coupling schemes give g-values that agree with the g-values experimentally found in the till now investigated spectra [3]).

When anomalous g-values occur one expects according to the theory of HEISENBERG, PAULI and LANDÉ, that however the g-values of the separate terms deviate from the normal ones, the g-sum of certain groups of terms will remain constant.

From the terms arising from the coupling of one electron one must join to groups the terms with equal j, then the sum of the g-values of the terms of such a group is constant and can be calculated beforehand. This sum is equal to the sum of LANDÉ's g-values for these terms.

This rule is tested by BACK in the case of *Ne I*. Also for the ionised inert gases the rule holds very well. (See Tables 4 and 5.)

Table 3 contains the magnetic separations of lines that are combinations of the 5*s* and 5*p* terms (^3P) of simply ionised Krypton (*Kr II*). The wavelengths (I. Å.) and intensities are taken from BLOCH c.s. In the third

---

[1]) E. BACK: Ann. der Phys. **76**, 317, 1925.

[2]) S. GOUDSMIT and G. E. ÜHLENBECK: Zeitschr. f. Phys. **35**, 618, 1926.

[3]) For the ionized inert gases the calculation has been performed by:
C. J. BAKKER: Versl. Kon. Ak. Amsterdam **37**, 835, 1928; Proceedings **31**, 1041, 1928.

TABLE 4.

λ	Termcomb. x—y		Magnetic separation	g_x		g_y		Remarks
				theor.	obs.	theor.	obs.	
4846.58	5s $^2P_2$—5p $^2P_1$	L	**(0.33)** 1.00 **1.67**	1.33	1.52	0.67	1.78	1)
		obs.	**(0.12)** **1.38**					
		calc.	**(0.13)** **1.39** 1.65					
4811.73	5s $^4P_1$—5p $^4D_2$	L	**0.47** **(0.73)** 1.93	2.67	2.64	1.20	1.26	2)
		obs.	**0.64^5**					
		calc.	**0.57** **(0.69)** 1.95					
4765.72	5s $^4P_2$—5p $^4D_3$	L	**(0.18)** (0.54) **0.83** 1.19 1.55 1.91	1.73	1.54	1.37	1.23	3)
		obs.	**(0.15^5)** (0.46) **0.76** 1.07 1.38 1.69					
		calc.	**(0.15^5)** (0.46) **0.76** 1.07^5 1.38^5 1.70					
4762.42	5s $^2P_1$—5p $^2D_2$	L	**(0.07)** 0.73 **0.87**	0.67	0.70	0.80	1.33	4)
		obs.	**(0.31^5)** 1.01 **1.65**					
		calc.	**(0.32)** 1.02 **1.65**					
4738.98	5s $^4P_3$—5p $^4P_3$	L	(0.00) 1.60	1.60	1.60	1.60	1.60	5)
		obs.	(0.00) 1.58					
		calc.	(0.00) 1.60					
4680.39	5s $^2P_1$—5p $^2S_1$	L	(0.67) 1.33	0.67	0.70	2.00	1.50	6)
		obs.	(0.41) 1.09					
		calc.	(0.40) 1.10					
4658.86	5s $^4P_3$—5p $^4P_2$	L	**(0.07)** (0.20) **1.40** 1.53 1.67 1.80	1.60	1.60	1.73	1.67	7)
		obs.	**(0.00)** **1.51**					
		calc.	**(0.03)** (0.09) **1.49** 1.55 1.61 1.67					
4619.13	5s $^2P_2$—5p $^2D_3$	L	**(0.07)** (0.20) **1.00** 1.13 1.27 1.40	1.33	1.52	1.20	1.34	8)
		obs.	**(0.00)** **1.21**					
		calc.	**(0.09)** (0.27) **1.07** 1.25 1.43 1.61					
4615.28	5s $^2P_2$—5p $^2P_2$	L	(0.00) 1.33	1.33	1.52	1.33	1.26	
		obs.	**(0.33)** 1.15 **1.37** —					
		calc.	(0.13) **(0.39)** 1.13 **1.39** 1.65					
4436.81	5s $^4P_1$—5p $^2P_2$	L	**(0.67)** **0.67** 2.00	2.67	2.64	1.33	1.26	9)
		obs.	**0.63** 1.94					
		calc.	**0.57** **(0.69)** 1.95					
4431.68	5 s$^4P_1$—5p $^4D_1$	L	(1.33) 1.33	2.67	2.64	0.00	0.00	10)
		obs.	(1.31^5) 1.31^5					
		calc.	(1.32) 1.32					
4355.50	5s $^4P_3$—5p $^4D_4$	L	**(0.09)** (0.26) (0.43) **1.00** 1.17 1.34 1.51 1.69 1.86	1.60	1.60	1.43	1.43	11)
		obs.	**(0.00)** **1.06**					
4300.51	5s $^2P_2$—5p $^4S_2$	L	(0.33) **(1.00)** 1.00 **1.67** 2.33	1.33	1.52	2.00	1.54	
		obs,	**(0.00)** **1.51**					
		calc.	**(0.01)** (0.03) 1.51 **1.53** 1.55					
4292.94	5s $^4P_2$—5p $^4D_2$	L	(0.27) **(0.80)** 0.93 **1.47** 2.00	1.73	1.54	1.20	1.26	12)
		obs.	**(0.43)** 1.12 **1.39** 1.67					
		calc.	(0.14) **(0.42)** 1.12 **1.40** 1.68					

TABLE 4 (*Continued*).

λ	Termcomb. x—y		Magnetic separation						g_x		g_y		Remarks
									theor.	obs.	theor.	obs.	
4250.60	5s $^2P_2$—5p $^2D_2$	L	(0.27)	0.53	**(0.80)**	**1.07**	1.60		1.33	1.52	0.80	1.33	
		obs.		**(0.20)**		**1.40**							
		calc.	(0.09)	**(0.28)**	1.24	**1.43**	1.61						
4185.13	5s $^2P_2$—5p $^2S_1$	L	**(0.33)**	**1.00**	1.67				1.33	1.52	2.00	1.50	13)
		obs,	**(0.00)**	**1.51**^{5}									
		calc.	**(0.01)**	1.51	**1.53**								
4145.13	5s $^4P_1$—5p $^4S_2$	L	**(0.33)**	**1.66**	2.33				2.67	2.64	2.00	1.54	14)
		obs.	**(0.55**^{5})	**0.99**	2.10								
		calc.	**(0.55)**	**0.99**	**2.09**								
4098.74	5s $^4P_1$—5p $^2D_2$	L	**0.13**	**(0.93)**	1.73				2.67	2.64	0.80	1.33	15)
		obs.		**0.66**	1.97								
		calc.	**(0.65)**	**0.68**	1.98^5								
4037.81	5s $^4P_1$—5p $^2S_1$	L	(0.33)	2.33					2.67	2.64	2.00	1.50	16)
		obs.	(0.57)	2.09									
		calc.	(0.57)	2.07									
3994.83	5s $^4P_2$—5p $^2D_3$	L	**(0.27)**	**0.40**	(0.80)	0.93	1.47	2.00	1.73	1.54	1.20	1.34	17)
		obs.	**(0.00)**			**1.13**							
		calc.	**(0.10)**	(0.30)	**1.04**	**1.24**	1.44	1.64					
3912.54	5s $^4P_3$—5p $^4D_2$	L	**(0.20)**	(0.60)	1.00	1.40	1.80	**2.20**	1.60	1.60	1.20	1.26	18)
		obs.	**(0.17)**	(0.52)		—	—	**2.09**					
		calc.	**(0.17)**	(0.51)	1.09	1.43	1.77	**2.11**					
3754.20	5s $^4P_2$—5p $^4S_2$	L	(0.13)	**(0.40)**	1.60	**1.87**	2.13		1.73	1.54	2.00	1.54	19)
		obs.	(0.00)	1.55									
		calc.	(0.00)	1.54									
3666.00	5s $^4P_2$—5p $^2S_1$	L	**(0.13)**	**1.60**	1.87				1.73	1.54	2.00	1.50	20)
		obs.	**(0.00)**		**1.58**								
		calc.	**(0.02)**	1.52	**1.59**								
3460.09	5s $^4P_3$—5p $^4S_2$	L	**(0.20)**	(0.60)	**1.00**	1.40	1.80	2.20	1.60	1.60	2.00	1.54	
		obs.	**(0.00)**				—	**1.67**					
		calc.	**(0.03)**	(0.09)	1.51	1.57	1.63	**1„69**					

REMARKS.

1. rather sharp quartet.
2. diffuse doublet.
3. sharp and completely resolved. See plate.
4. sharp sextet. On short wavelength side slight disturbance of other weak line. See plate.
5. sharp triplet.
6. sharp quartet. See plate.
7. strong triplet, diffuse. Intensity decrease to the outside.
8. diffuse triplet. Intensity decrease to the outside.
9. quartet with very strong inner components.
10. sharp doublet.

11. strong "Pseudo triplet" Central component enlarged; in both the other large components decrease of intensity clearly to the outside.
12. sharp. See plate.
13. rather sharp triplet!! See plate.
14. sharp sextet.
15. quartet with strong inner components.
16. weak, sharp quartet.
17. triplet on the edge of the plate. Decrease of intensity to the outside.
18. The outer components are strong and show a decrease of intensity to the inside; the structure in the outer components is difficult to measure.
19. very sharp triplet!!
20. very weak triplet.

column is *L*- the magnetic separation calculated with the *g*-formula of LANDÉ.

obs. = the observed magnetic separation.

calc. = the magnetic separation calculated with anomalous *g*-values.

The last column contains the *g*-values of LANDÉ (theor.) and the observed *g*-values. (*obs.*)

In table 1 the *g*-values got in this way are placed behind the corresponding termvalues. Magnetic separations of combinations with the term $5p\ ^2P_1$ are not on our plates, so that the *g*-value of that term fails.

6. *Comparison of g-values of analogous terms.*

On account of theoretical considerations one expects that with increasing atomic number *g*-values of analogous terms show an increasing deviation from the normal *g*-values of LANDÉ. Tables 4 and 5 show that this rule holds very well.

Table 4 includes the *g*-values of analogous *s*-terms in ionised Neon (*Ne II*), ionised Argon (*Ar II*) and ionised Krypton (*Kr II*), besides in the first column the *g*-values calculated according to the formula of LANDÉ (coupling $\{ (s_1 s_2) (l_1 l_2\})$ and in the last column the *g*-values calculated according to the coupling scheme $\{ (s_1 l_1) (s_2 l_2) \}$ [1]). It is remarkable that deviating *g*-values appear for the terms with $j = 2$ of *Kr II* with such a suddenly large deviation from the normal values. The *g*-sum rule is fulfilled.

Table 5 includes the *g*-values of analogous *p*-terms. Among the 15 terms arising from the *p*-electron only 3 terms show yet normal *g*-values in the case of *Kr II*. The other terms have *g*-values, which with increasing atomic number show more or less strong deviations from the normal *g*-values. The increasing deviations of the *g*-values of the terms $np\ ^4S_2$, $np\ ^2D_2$ and $np\ ^2P_1$ are very remarkable, because those deviations increase suddenly and very strongly for ionised Krypton (*Kr II*). The agreement of the *g*-sums is excellent in all cases.

---

[1] Because for a *s*-electron $s_2 = 0$ the coupling schemes $\{ (s_1 l_1) (s_2 l_2) \}$, $[\{ (s_1 l_1) s_2 \} l_2]$ and $[\{ (s_1 l_1) l_2 \} s_2]$ give the same *g*-values in this case.

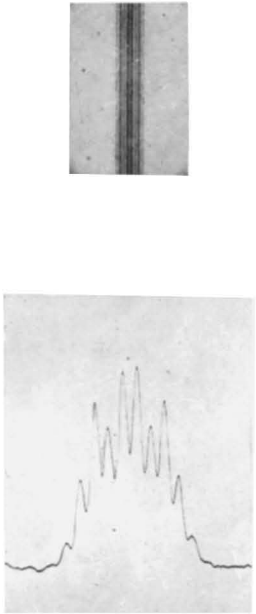
TABLE 5. Neon II $n = 3$; Argon II $n = 4$; Krypton II $n = 5$.

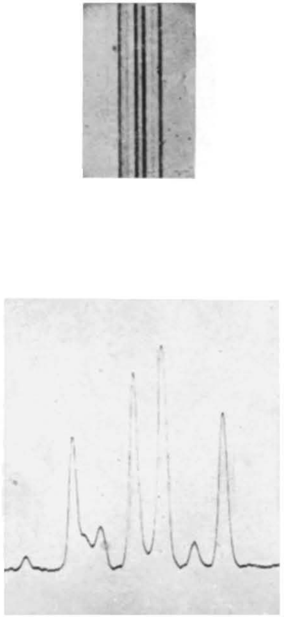
Term		g-values				
		LANDÉ $\{(s_1s_2)(l_1l_2)\}$	*Ne II*	*Ar II*	*Kr II*	$\{(s_1l_1)(s_2l_2)\}$
j = 3	ns $^4P_3$	1.60	1.60	1.60	1.60	1.60
j = 2	ns $^4P_2$	1.73	1.73	1.73	1.54	1.40
	ns $^2P_2$	1.33	1.33	1.33	1.52	1.66
		+ 3.06	+ 3.06	+ 3.06	+ 3.06	+ 3.06
j = 1	ns $^4P_1$	2.67	2.67	2.67	2.64	2.00
	ns $^2P_1$	0.67	0.67	0.67	0.70	1.34
		+ 3.34	+ 3.34	+ 3.34	+ 3.34	+ 3.34

TABLE 6. Neon II $n = 3$; Argon II $n = 4$; Krypton II $n = 5$.

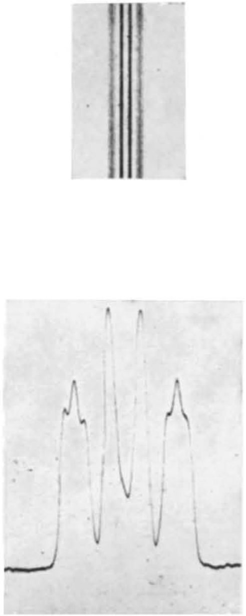
Term		g-values				
		LANDÉ $\{(s_1s_2)(l_1l_2)\}$	*Ne II*	*Ar II*	*Kr II*	$\{(s_1l_1)(s_2l_2)\}$
j = 4	np $^4D_4$	1.43	1.43	1.43	1.43	1.43
j = 3	np $^4D_3$	1.37	1.37	1.33	1.23	1.33
	np $^4P_3$	1.60	1.60	1.60	1.60	1.44
	np $^2D_3$	1.20	1.20	1.24	1.34	1.40
		+ 4.17	+ 4.17	+ 4.17	+ 4.17	+ 4.17
j = 2	np $^4D_2$	1.20	1.20	1.20	1.26	1.38
	np $^4P_2$	1.73	1.73	1.73	1.67	1.67
	np $^4S_2$	2.00	2.00	2.00	1.54	1.33
	np $^2D_2$	0.80	0.80	0.90	1.33	1.47
	np $^2P_2$	1.33	1.33	1.23	1.26	1.22
		+ 7.06	+ 7.06	+ 7.06	+ 7.06	+ 7.06
j = 1	np $^4D_1$	0.00	0.00	0.00	0.00	0.67
	np $^4P_1$	2.67	2.67	2.67		1.67
	np $^2P_1$	0.67	0.71	0.99	1.78	1.78
	np $^2S_1$	2.00	1.96	1.68	1.50	1.22
		+ 5.34	+ 5.34	+ 5.34	+	+ 5.34

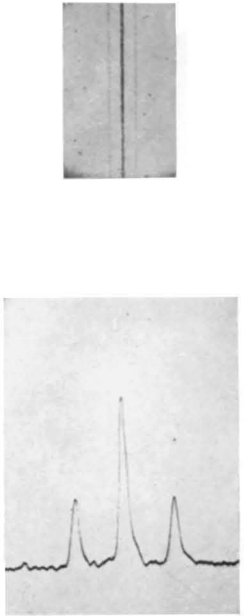
C. J. BAKKER AND P. ZEEMAN: THE MAGNETIC SEPARATION IN THE SPECTRUM OF IONISED KRYPTON (KRII)


4765.72
5 S $^4P_2$—5 p $^4D_3$


4762.42
5 S $^2P_1$—5 p $^2D_2$


4680.39
5 S $^2P_1$—5 p $^2S_1$


4292.94
5 S $^4P_2$—5 p $^4D_2$


4185.13
5 S $^2P_2$—5 p $^2S_1$

7. *Summary.*

The magnetic separation of the *Kr II* spectrum has been investigated. The g-values of the terms arising from the coupling of the 5*s* and 5*p* electron have been fixed and it is shown that g-values with strong "anomality" appear. The g-sum rule has been confirmed. A comparison of the g-values of analogous terms in the spectra of *Ne II*, *Ar II* and *Kr II* is given.

Laboratory "Physica" of the University
Amsterdam.

May, 1929.

DESCRIPTION OF THE PLATE.

The enlargement of the reproductions of the original magnetic separations is 9 times. The photograms are made by means of a photometer of Zeiss, provided with photo electric cell and electro meter. The distances of the tops in the photograms are about 33 times those of the corresponding magnetic components on the original plate.

It is remarkable that in some cases the intensities of analogous magnetic components (lying on the same distance from the middle) are not equal. See $\lambda = 4762.42$ and $\lambda = 4680.39$.

Both the lines $\lambda = 4680.39$ and $\lambda = 4185.13$ that form a ^2P—^2S doublet, just as for instance the well known *Na*-doublet D_1 and D_2, show very clearly the effect of the "anomalous" g-values. The combination $^2P_2$—$^2S_1$ that splits up in the case of normal g-values in a sextet with aequidistant components has become here a sharp triplet!