Physics. — *Note on regularities in the spectra of Fluorine and Chlorine.* By T. L. DE BRUIN. (Communicated by Prof. P. ZEEMAN).

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Little progress has been made in the detection of regularity in the spectra of the halogens (Fl . Cl . Br . J). Data concerning a revision of the observations would seem to be necessary for the study of the structure of these spectra.

Fluorine. Measurements of the Fluorine spectrum have been made by PORLEZZA [1]) and by GALE and MONK [2]). The spectrum as measured by them consisted of a group of some 50 lines in the red (probably F. I) and a group of about 30 lines in the violet (probably F. II).

I have investigated these lines on constant differences and have found:

Fl. I 145,5, 160.1 and 274.6
Fl. II narrow triplets with $\Delta \nu = \pm$ 12 and 20.

There are also in the F. I spectrum groups of lines with the constant differences 160.1 and 274.6. From the 3 to 5 interval ratio of these differences we have deduced a quartetterm (innerquantumnumbers 1, 2, 3; ^4P). Recently CARRAGAN [3]) has made a study of the ZEEMANeffects for some of the lines of the red group. These ZEEMANeffects showed the reality of this ^4P-term. CARRAGAN has deduced a ^4D-term, forming with the ^4P-term the multiplet λ 6708—6909.

This note records the detection of different quartet- and doubletterms in the spectrum of F. I. The structure of the spectrum resembles the spectra of N. I. [4]) and O. II [5]). In the light of the theory of complex spectra developed by HUND [6]) the deepest lying term in the spectra of the neutral halogen atoms would be a ^2P-term. The following terms would be expected too: ^4P, ^2P; ^4D, ^4P, ^4S, ^2D, ^2P, ^2S; ^4F, ^4D, ^4P, ^2F, ^2P, ^2D. The components of any one of the terms would be probably inverted i. e. the component with the largest j value will be the "deepest".

The detected termcombinations are recorded in the following tables.

1) PORLEZZA: Gaz. Chim. Ital. **42**, 42, 1912.
2) GALE and MONK: Astr. Journ. **59**, 125, 1924.
3) H. CARRAGAN: Astr. Journ. **63**, 145, 1926.
4) C. C. KIESS: Journal Opt. Soc. America. Vol. **11**, 1, 1925.
5) A. FOWLER: Proc. R. S. London. Vol. **110**, 476, 1926.
6) F. HUND: Zeitschr. f. Phys. **33**, 345, 1925.

1.

	$^4P_1$	160.0	$^4P_2$	274.5	$^4P_3$
$^4D_4$	—				40.
					6856.01
					14581.7
176.6					
$^4D_3$	—		30.		20.
			6902.46		6773.96
			14483.7	274.6	14758.3
144.4					
$^4D_2$	20.		18.		1.
	6909.79		6834.25		6708.36
	14468.2	159.9	14628.1	274.5	14902.6
83.4					
$^4D_1$	18.		3.		—
	6870.21		6795.47		
	14551.6	160.0	14711.6		

2.

	23.		28.		30.
	6413.61		6348.46		6239.63
$^4S_2$	15587.5	160.0	15747.5	274.6	16022.1

3.

$^4P'_3$	—		5.		20.
			7552.20		7398.96
			13237.5	274.2	13511.7
122.7					
$^4P'_2$	5.		5.		18.
	7573.32		7482.95		7332.25
	13200.6	159.4	13360.0	274.6	13634.6
102.1					
$^4P'_1$			12.		—
			7426.2		
	(13302.7)		13462.1		

4.

	6.		5.		1.
	6762.91		6690.48		6569.66
	14782.1	160.3	14942.4	274.9	15217.3
	4.		3.		20.
	6580.36		6650.40		6773.96 [1]
	15192.5	160.0	15032.5	274.2	14758.3
	3.		2.		4.
	6210.85		6149.77		6047.55
	16096.4	159.9	16256.3	274.7	16531.0

5.

	$^2P_2$		$^2P_1$		
$^2P'_1$	15.		5.		
	7202.34		7128.36		
	13880.6	144.0	14024.6		
325.6 [2]					
$^2P'_2$	50.		4.		
	7037.48		6966.33		
	14205.7	145.1	14350.8		

6.

	18.		3.		
	6834.25 [1]		6766.98		
	14628.1	145.4	14773.5		
	3.		1.		
	6416.30		6356.87		
	15581.0	145.6	15726.6		
	0.		1.		
	6049.66		5996.76		
	16525.2	145.8	16671.0		
	3.		00.		
	5707.23		5659.02		
	17516.8	149.2	17666.0		

[1] Also in multiplet 1.

[2] We will remark that the theoretical value for the doublet

$$\Delta\nu_L = 0.365\,(9-3.5)^4 = 333.9.$$

ZEEMANeffects.

The publication of CARRAGAN deals with only the ZEEMANtypes, not the observations in decimal form. The results here recorded are therefore somewhat incertain.

Multiplets 1 and 2.

The lines of these groups have ZEEMANeffects consisted with the suggested arrangement.

Multiplet 3.

20.	λ 7398.96	calc.	(0)	1.60					
		obs.	(0)	1.66					
5.	λ 7552.20	calc.	**(0.07)**	(0.20)	**1.40**	1.53	1.67	1.80	
		obs.	(0)		1.50				
5.	λ 7573.32	calc.	**(0.47)**	**1.27**	2.20				
		obs.	(0.50)	1.35					
18.	λ 7332.25	calc.	**(0.07)**	(0.20)	**1.40**	1.53	1.67	1.80	
		obs.	(—	0.25)	**1.35**	—			
12.	λ 7426.2	calc.	**(0.47)**	**1.27**	2.20				
		obs.	(0.50)	1.30	2.30				

Multiplet 4.

These lines form a possible term combination with ^4P.

Multiplet 5.

The observed ZEEMANeffect of the lines λλ 7202.34, 7037,48 and 6966.33 agrees with calculation. For the line λ 7128.36 the calculation gives $\frac{(0)\ 2}{3}$; the observed patterns are, however, $\frac{(0)\ 3}{4}$.

Multiplet 6.

These lines form a possible termcombination with ^2P. ZEEMANeffect not observed.

It should be remarked that the interval rule is confirmed in ^4P and ^4D. For the $^4P'$ term, however, there is a deviation from this rule [1]). Only the strong line (15) 7311.40 with the ZEEMANeffect $\frac{(6)\ \mathbf{21.33}}{20}$ could not be tabulated. The line has two close satellites λλ 7309.28 and 7314.52. The ZEEMANeffect suggests a $^4D_3\,^2D_2$ termcombination.

calc.	**(0.29)**	0.51	(0.86)	1.09	1.66	**2.23**
obs.	(0.30)			**1.05**	1.65	

Chlorine. Measurements of the spectra of Chlorine were made by EDER and VALENTA [2]), JEVONS [3]) and ANGERER [4]). NELTHORPE [5]) has

[1]) See also the spectra N I and O II.

[2]) EDER und VALENTA: Wien. Denkschr. **68**, 1, 1899.

[3]) JEVONS: Proc. R. S. London. **103**, 1923.

[4]) ANGERER: Zeitschr. f. wiss. Photogr. **22**, 1924.

[5]) NELTHORPE: Astr. Journ. **41**, 16, 1915.

found that many of the vacuum tube lines of Chlorine as tabulated by EDER and VALENTA, did not appear in "Grundspektrum" tubes. These lines are also due to Cl. I. It is probable that the observed spectrum contains lines of Cl. II and Cl. III too. (L. and E. BLOCH [1]).

The red lines (EDER and VALENTA) examined for constant differences show: 40.5; 67.2 (107.7) and 530.5. The differences 40.5 and 67.2 are already found by PAULSON [2]). PASCHEN [3]) has identified these differences as a ^5P term of Cl. II.

In connection with the work of NELTHORPE and L. and E. BLOCH, the difference 530.5 is probable a frequency difference in the Cl. I. spectrum. The following table contains a number of these doublets.

Int.	$\lambda_{(Row)}$	$\nu_{vac.}$	Int.	$\lambda_{(Row)}$	$\nu_{vac.}$	$\Delta\nu$
3	4740.51	21088.9	3	4624.23	21619.1	530.2
1/2	4649.1	21504.0	1/2	4537.0	22034.8	530.8
4	4601.19	21727.4	3	4491.25	22259.2	531.8
1/2	4504.50	22193.8	2	4399.37	22724.1	530.3
4	4475.50	22337.6	2	4371.72	22867.9	530.3
2	4446.35	22484.1	10	4343.82	23014.8	530.7
4	4438.72	22522.7	5	4336.38	23054.2	531.5
8	4380.08	22824.2	3	4280.61	23354.6	530.4
6	4369.68	22878.6	3	4270.72	23408.7	530.1
8	4363.46	22911.2	3	4264.75	23441.5	530.3
1	4333.12	23071.6	4	4235.68	23602.3	530.7
6	4323.53	23122.8	7	4226.58	23653.1	530.3
4	4304.21	23226.6	4	4208.16	23756.7	530.1
7	4226.58	23653.1	3	4133.83	24183.8	530.7

It should be remarked that some of the differences found in the F. I and Cl. I spectrum, have approximately the ratio of the squares of the atomnumbers i. e. 3.57.

		Ratio.
Fl. I 145.5	Cl. I 530.5	3.6
Fl. II 12; 20	Cl. II 40.5; 67.2	3.3

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[1]) L. et E. BLOCH: C. R. **180**, 1740, 1925. SUGIURA: Journ. de Phys. **6**, 10, 323, 1925.
[2]) PAULSON; Astr. Journ. **40**, 289, 1914.
[3]) PASCHEN: Ann. d. Phys. **71**, 559, 1923.