THE SPECTRUM OF TREBLY IONISED MERCURY.

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The analysis of the higher spark spectra of the elements has received a fresh impetus from the recent advances in the technique of accurate wavelength determination in the extreme ultra-violet region bordering on soft X-rays. Some of the complicated spectra of the heavy elements and of the rare earths have also been successfully attacked in recent times. The Os-Ir-Pt group is an example; the arc spectra of these elements have now been analysed,[1] but the spark spectra which are even richer in lines have not yet been investigated. Since Ir I, Pt II, Au III and Hg IV form an isoelectronic sequence, the spectrum of Hg IV has been taken up in this work with the hope of analysing Pt II and Au III subsequently. A complete analysis of these rich spectra may throw light on any modifications that may be required in Hund's theory.

The wavelength data have been taken from Carroll (*Phil. Trans. Roy. Soc.*, **A, 225**, 396, 1926), L. & E. Bloch (*Journ. de Physique*, **4**, 332, 1923), G. Déjardin (*Annales de Physique*, **8**, 424, 1927) and R. Ricard (*Comptes Rendus*, **192**, 618, 1931). All these authors excepting Carroll have classified the lines into four classes corresponding to Hg I, II, III and IV. Since the fundamental lines of Hg IV are to be expected in the extreme ultra-violet region covered by Carroll, from whose list Hg IV lines cannot be easily picked up, constant wave-number differences equal to those between prominent Hg IV lines in the visible and near ultra-violet regions were looked for amongst Carroll's lines, and the fundamental multiplets of Hg IV were thus discovered. These are given in Table II. The expected terms according to Hund's theory are given in Table I. Many other terms have been found and all the term values fixed to within 1 or 2 wave-numbers by means of combinations in the region above 2000 Å. All the terms so found, together with their J-values are given in Table III. The fundamental low terms are ^4F terms from the configurations d^8s and d^7s^2 and ^2D terms from d^9. The other

[1] Pt. Livingood, *Phys. Rev.*, **34**, 185, 1929.
Ir. W. Albertson, *Phys. Rev.*, **42**, 443, 1932.
Os. W. Albertson, *Phys. Rev.*, **45**, 394, 1934.

even and odd terms are denoted by numerals since it is difficult and almost meaningless to give their L and S values. It is also interesting to find that the d^9 ^2D-separation comes out to be 8184 cm^{-1} while from a Rydberg formula applied to two series of two terms each discovered by the author in Hg III (M.Sc. Thesis) this interval was expected to be about 8800 cm^{-1}. Considering the accuracy to be expected from such an extrapolation, the agreement is good. In all 23 low even terms and 31 middle odd terms have been found, thus accounting for about 200 lines. Table IV gives a list of all the classified lines. With regard to the agreement between calculated and observed wave-numbers, even such a difference as 15 cm^{-1} has to be tolerated in the case of Carroll's lines which are given only to one decimal place and in which there may sometimes be an error of 0·2 to 0·3 Å. In the region above 2000 Å the agreement is within 1 cm^{-1} but sometimes 2 or 3 cm^{-1} have had to be allowed since the term values themselves are not accurate to more than 1 or 2 cm^{-1}.

TABLE I.

Configuration	Expected Terms
$5d^8$ 6s	^{4}(PF), ^{2}(PF), ^{2}(SDG)
$5d^7$ $6s^2$	^{4}(PF), ^{2}(PDFGH), ^{2}D
$5d^9$	^{2}D
$5d^8$ 6p	^{4}(DFG), ^{2}(DFG), ^{4}(SPD), ^{2}(SPD), ^{2}(FGH), ^{2}(PDF), ^{2}(SP)

TABLE II.

		d^8s				d^7s^2			
		$^4F_{9/2}$	$^4F_{7/2}$	$^4F_{5/2}$	$^4F_{3/2}$	$^4F_{9/2}$	$^4F_{7/2}$	$^4F_{5/2}$	$^4F_{3/2}$
d^8p	$^4F^\circ_{9/2}$	(3) 70567 *5087*	(0) 63000 *5087*	..	..	(2) 64914 *5085*	(0) 62665 *5090*	..	..
	$^4F^\circ_{7/2}$	(1) 75654	(2) 68087 *4042*	(0) 63565 *4039*	..	(0) 69999	(2) 67755 *4027*	(1) 66181 *4024*	..
	$^4F^\circ_{5/2}$	..	(0) 72129	(1) 67604 *3193*	(0) 64259 *3186*	..	(1) 71782	(1) 70205 *3195*	(1) 69085 *3206*
	$^4F^\circ_{3/2}$	..	..	(0) 70797	(0) 67445	..	..	(0) 73400	(1) 72291

TABLE III.

Even Levels				Odd Levels			
Designation	J	Term Value	Remarks	Designation	J	Term Value	Remarks
1	4½	0	$d^8s\ {}^4F_{9/2}$	1°	4½	70567	$d^8\,p\,{}^4F°_{9/2}$
2	2½	2192	$d^9\ {}^2D_{5/2}$	2°	5½	74419	$d^8p\,{}^4G°_{11/2}$
3	4½	5653	$d^7s^2\ {}^4F_{9/2}$	3°	3½	74702	
4	3½	7557	$d^8s\ {}^4F_{7/2}$	4°	3½	75388	
5	3½	7897	$d^7s^2\ {}^4F_{7/2}$	5°	3½	75655	$d^8p\,{}^4F°_{7\cdot2}$
6	2½	9476	$d^7s^2\ {}^4F_{5/2}$	6°	2½	75772	
7	1½	10376	$d^9\ {}^2D_{3/2}$	7°	3½	77045	
8	1½	10592	$d^7s^2\ {}^4F_{3/2}$	8°	3½	78556	
9	2½	12084	$d^8s\ {}^4F_{5/2}$	9°	2½	79688	$d^8p\,{}^4F°_{5/2}$
10	1½	15438	$d^8s\ {}^4F_{3/2}$	10°	3½	79919	
11	2½	21011	$d^8s\ {}^4P_{5/2}$	11°	4½	81039	$d^8p\,{}^4G°_{9\cdot2}$
12	1½	23270	$d^8s\ {}^4P_{3/2}$	12°	1½	82884	$d^8p\,{}^4F°_{3/2}$
13	2½	24054	$d^7s^2\ {}^4P_{5/2}$	13°	3½	85056	$d^8p\,{}^4D°_{7/2}$
14	½	24564	$d^8s\ {}^4P_{1/2}$	14°	2½	85091	
15	1½	25001	$d^7s^2\ {}^4P_{3/2}$	15°	3½	86380	
16	½	25802	$d^7s^2\ {}^4P_{1/2}$	16°	1½ or 2½	87185	
17	4½	42131		17°	3½	87825	$d^8p\,{}^4G°_{7/2}$
18	2½ or 3½	44599		18°	2½	88216	$d^8p\,{}^4D°_{5/2}$
19	3½	53342		19°	1½	89513	$d^8p\,{}^4D°_{3/2}$
20	3½	55664		20°	½	90327	$d^8p\,{}^4D°_{1/2}$
21	2½	57122		21°	2½	91752	
22	3½	57270		22°	2½	92237	$d^8p\,{}^4G°_{5/2}$
23	3½	59490		23°	1½ or 2½	101826	
				24°	2½	102255	
				25°	2½	102353	
				26°	1½ or 2½	106210	
				27°	2½	106385	
				28°	1½	106748	
				29°	1½ or 2½	108798	
				30°	2½	113648	
				31°	2½	114508	

TABLE IV.

Int.	λ	ν	Comb.	ν calc.	Int.	λ	ν	Comb.	ν calc.
0	7517·8	13298·1	22– 1°	297	1	4206·10	23768	22–11°	769
1	6709·5	14900·1	20– 1°	903	2	4161·65	24022·2	20– 9°	024
0	6288·6	15896·7	23– 4°	898	2	3964·83	25214·7	19– 8°	214
1	5804·3	17224	19– 1°	225	1	3880·90	25759·9	21–12°	762
1	5001·3	19989·2	20– 5°	991	3	3578·75	27934·8	21–13°	934
2	4949·53	20198·3	23– 9°	198	2	3528·32	28334	23–17°	335
1	4676·0	21380	20– 7°	381	2	3515·7	28435·7	17– 1°	436
1	4664·2	21434	21– 8°	434	1	3416·86	29258	21–15°	258
1	4639·3	21549	23–11°	549	2	3401·35	29391·7	20–13°	392
1	4534·49	22047	19– 4°	046	4	3321·01	30102·7	18– 3°	103
1	4480·49	22313	19– 5°	313	1	3271·9	30555	22–17°	555
2	4459·18	22419	22– 9°	418	2*d*	3256·05	30703·2	21–17°	703
1	4413·83	22650	22–10°	649	2	3230·7	30944	22–18°	946
1	4385·57	22796	21–10°	797	2	3219·0	31057	18– 5°	056

Int.	λ	ν	Comb.	ν calc.	Int.	λ	ν	Comb.	ν calc.
1	3215·1	31094	21–18°	094	2	1468·7	68087	4–5°	098
1	3152·4	31713	19–13°	714	3	1465·8	68222	4– 6°	215
2	3148·8	31749	19–14°	749	4	1454·2	68766	3– 2°	766
1	3096·22	32288	17– 2°	288	2	1448·3	69046	3– 3°	049
1	3086·5	32390	21–19°	391				18–30°	049
1	3081·0	32448	18– 7°	446	1	1447·5	69085	8– 9°	096
1	3070·96	32553·7	20–18°	552				6– 8°	080
1	3052·8	32747	23–22°	747	3	1442·7	69314	7– 9°	312
1	2899	34485	22–21°	482	0	1435·9	69643	10–14°	653
			19–17°	483	0	1434·2	69725	3– 4°	735
1	2886·90	34629	21–21°	630	0	1430·2	69920	18–31°	909
2	2863·46	34912·6	17– 7°	914	0	1428·6	69999	3– 5°	70002
2	2859	34967	22–22°	967	1	1424·4	70205	6– 9°	212
1	2849·16	35087·8	18– 9°	089	3	1417·1	70567	1– 1°	567
0	2570·4	38893	19–22°	895	4	1415·0	70671	5– 8°	659
0	2569·18	38911	17–11°	908	0	1413·7	70736	11–21°	741
1	2392·74	41780·4	18–15°	781	0	1412·5	70797	9–12°	800
0	2312·72	43225·8	18–17°	226	3	1400·6	71398	3– 7°	392
0	2098·54	47637	18–22°	638	5	1393·9	71741	10–16°	747
0	2043·8	48913	19–24°	913	1	1393·1	71782	5– 9°	791
0	1904·7	52502	12– 6°	502	0	1386·4	72129	4– 9°	131
1	1658·1	60308	19–30°	306	1	1383·3	72291	8–12°	292
2	1657·1	60346	10– 6°	334	M3	1379·1	72511	2– 3°	510
1	1639·4	60998	13–13°	61002				7–12°	508
0	1638·3	61039	13–14°	027	1	1371·8	72897	3– 8°	903
1B*	1617·6	61820	12–14°	821	0	1370·1	72987	9–13°	972
0	1595·8	62665	5– 1°	670	1	1367·2	73142	5–11°	143
0	1587·3	63000	4– 1°	010	0	1362·4	73400	6 12°	408
1B	1581·9	63215	15–18°	215	2	1361·4	73454	2– 5°	463
0	1573·2	63565	9– 5°	571	1?	1361·0	73475	4–11°	482
1B	1570·3	63682	9– 6°	688	1	1350·3	74058	10–19°?	075
1	1569·6	63711	16–19°	711	0	1346·6	74261	3–10°	266
2	1561·5	64041	11–13°	045	0	1345·9	74300	9–15°	296
1	1560·6	64078	11–14°	080	2δ	1343·7	74421	1– 2°	419
0	1558·6	64160	13–18°	162	1	1342·3	74499	8–14°	499
0	1556·2	64259	10– 9°	250	2	1338·7	74699	1– 3°	702
1	1549·8	64524	15–19°	512	3	1335·8	74862	2– 7°	853
			16–20°	525	M3	1335·2	74895	10–20°	889
2	1540·5	64914	3– 1°	914	1	1331·8	75086	9–16°?	101
2	1539·9	64939	14–19°	949	M3δ	1326·5	75386	1– 4°	388
			12–18°	946				3–11°	386
1	1533·9	65193	8– 6°	180	M3	1323·3	75569	6–13°	580
1	1533·3	65218	6– 3°	226	1	1321·8	75654	1– 5°	655
1B	1530·9	65321	15–20°	326	0	1320·4	75735	9–17°	741
M3†	1527·5	65466	13–19°	459	1	1313·5	76132	9–18°	132
0	1520·4	65772	14–20°	763	1	1310·4	76313	10–21°	314
1	1516·9	65924	6– 4°	912	2	1305·6	76593	8–16°	593
1	1511·0	66181	6– 5°	179	1	1302·1	76799	7–16°	809
0	1509·5	66247	12–19°	243				10–22°	799
1	1491·2	67060	12–20°	057	0	1297·8	77053	1– 7°	045
2	1488·3	67191	11–18°?	205	0	1296·1	77155	5–13°	159
0	1482·7	67445	10–12°	446	0	1295·4	77196	5–14°	194
2	1479·9	67572	6– 7°	569	1	1294·6	77244	15–24°	254
1	1479·2	67604	9– 9°	604	1	1292·9	77346	15–25°	352
2	1475·9	67755	5– 5°	758	0	1291·5	77429	9–19°	429
1	1473·4	67870	5– 6°	875	1	1290·6	77483	2– 9°	496

* B denotes a line given by L. & E. Bloch, *Journ. de Physique*, **2**, 249. 1921.

† M indicates blend with Hg III line classified by McLennan, McLay & Crawford, *Trans. Roy. Soc. Canada*, **22**, 248, 1928.

Int.	λ	ν	Comb.	ν calc.	Int.	λ	ν	Comb.	ν calc.
1	1290·1	77513	4–13°	499	0	1145·0	87336	2–19°	321
1	1288·3	77622	8–18°	624	1	1139·2	87781	11–29°	787
1	1284·8	77833	7–18°	840	1	1138·7	87820	1–17°	825
3	1277·2	78296	13–25°	299	3	1114·3	89742	9–23°	742
0	1272·9	78561	1– 8°	556	M1	1105·6	90449	13–31°	454
M4	1269·8	78753	6–18°	740	2	1101·6	90777	10–26°	772
1δ	1266·1	78983	12–24°	985	1	1099·6	90942	10–27°	947
1δ	1264·7	79070	12–25°	083	0	1096·0	91241	8–23°	234
1δ	1263·7	79133	7–19°	137				12–31°	238
2	1259·5	79397	3–13°	403	0	1095·2	91308	10–28°	310
1	1254·0	79745	8–20°	735	3	1093·5	91449	7–23°	450
2	1251·1	79930	1–10°	919	1	1091·0	91659	8–24°	663
			5–17°	928	1	1089·9	91752	8–25°	761
0	1249·2	80051	6–19°	037	4	1082·8	92353	6–23°	350
1δ	1247·6	80154	9–22°	153	0	1071·2	93353	10–29°	360
1	1245·7	80276	4–17°	268	1	1058·9	94438	5–25°	456
2	1239·8	80658	4–18°	659	2δ	1045·8	95621	8–26°	618
2	1238·8	80723	3–15°	727	3	1043·8	95804	8–27°	793
1	1235·4	80945	16–28°	946	2	1039·8	96172	8–28°	156
1	1233·9	81044	1–11°	039	0	1037·7	96367	7–28°	372
2	1231·9	81175	8–21°	160	1	1031·8	96918	6–27°	909
0	1223·3	81746	15–28°	747	1	1018·2	98213	8–29°	206
1	1216·8	82183	3–17°	172				10–30°	210
3	1206·6	82878	2–13°	864	0	1015·4	98483	5–27°	488
0	1192·4	83864	5–21°	855	2	1009·4	99069	10–31°	070
2δ	1187·8	84189	2–15°	188	1	976·2	102438	9–31°	424
			4–21°	195	1δ	970·4	103050	8–30°	056
0	1180·8	84688	4–22°	680	1	968·4	103263	7–30°	272
2	1175·7	85056	1–13°	056	0	962·2	103929	8–31°	916
0	1173·9	85186	11–26°	199	1	961·4	104015	2–26°	018
1	1162·6	86014	2–18°	024	1	956·6	104537	2–28°	556
2	1157·6	86386	1–15°	380	3	942·7	106078	4–30°	091
			10–23°	388					
1δ	1151·9	86813	10–24°	817	2	938·0	106610	2–29°	606
0	1150·5	86919	10–25°	915				5–31°	611