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# THE FIRST SPARK SPECTRUM OF TELLURIUM

## PART I

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**ABSTRACT.** Based on an extensive experimental study of the Emission spectrum of Tellurium, the general features of the structure of the first spark spectrum of the element have been identified. A related system of quartet and doublet terms has been set up, involving the characteristic terms of the 5s, 6s and 6p electron configurations of the singly ionised atom of Tellurium. The ionisation potential of Te II is derived to be 21·5 volts approximately.

### INTRODUCTORY

In three previous papers,[1] the analyses of the higher spark spectra of Tellurium Te VI, Te V, Te IV and Te III were published. The present paper is a continuation of the above work and deals with the structure of the first spark spectrum of the element due to the singly ionised atom. A preliminary notice of the work appeared in 'Nature.'[2]

### EXPERIMENTAL

The experimental work consisted in an extensive investigation of the spectrum of Tellurium as excited especially in condensed discharges through Tellurium vapour contained in quartz capillary tubes and in vacuum sparks between Aluminium Electrodes tipped with Tellurium. The measurements were made on plates taken with large Glass and Quartz Spectrographs for the visible and ultra-violet and with a tangential incidence 5-ft. Concave Grating Instrument in the vacuum region. A full account of this experimental work was already given in the papers referred to above.

### PREDICTED TERMS

The singly ionised Tellurium Atom contains 51 outer electrons like the neutral atom of Antimony and the more important spectral terms theoretically deduced as characteristic of such an Electron Configuration are briefly given below :

| Term Prefix | Predicted Terms | | |
|---|---|---|---|
| | Limit $^3P$ | $^1D$ | $^1S$ |
| 5p | $^4S$ | $^2D$ | $^2P$ |
| 6s | $^4P$ $^2P$ | $^2D$ | $^2S$ |
| 6p | $^4D$ $^4P$ $^4S$ | $^2F$ $^2D$ | $^2P$ |
| | $^2D$ $^2P$ $^2S$ | $^2P$ | |

All the above terms have been identified with the exception of a few doublets based on the $^1D$ and $^1S$ states of the ion.

## ANALYSIS

The identification of the various multiplets has been based primarily on the detection of the fundamental resonance combination 5p $^4S-6s\ ^4P$ consisting of the three lines in the vacuum grating region $\nu\nu$ 86094, 82742 and 78447. All the lines in the region where this group might be expected have been very closely scrutinised and no alternative choice of this group could be arrived at, consistent with the behaviour of the lines under different experimental conditions and the probable disposition of this group. The choice has been confirmed also by a study of the two available lists of lines of Tellurium in this region, one due to Bloch[3] and another (unpublished) due to Professor R. J. Lang of Edmonton (private communication). It has been possible with the aid of this group to extend the identification to the region of longer wave-lengths and to detect the other multiplets formed by the combination of the 6p terms with 6s $^4P$. A related system of doublet and quartet terms has been set up through the discovery of several intercombination lines. The lines so far identified have been presented in the form of multiplets in Table I. For the sake of brevity, all the data, comprising of the wave-numbers, term values, and term intervals are included in a single multiplet table, which is self-explanatory. The wave-lengths of the lines are omitted in this part, as not quite necessary. The numbers in brackets are the usual visual estimates of the intensities of the lines. A complete catalogue of all the lines assigned to Te II will be given in a succeeding part dealing with the identification of the 4d terms and other higher members.

The Term Values quoted in the multiplet table have been calculated, as has been done by one of the authors in Se II,[6] from the two members of the series $6s\,{}^4P - mp\,{}^4S$, although the absolute values derived thus might be somewhat largely in error. The deepest term $5p\,{}^4S$ gives the second ionisation potential of Tellurium to be 21·5 volts approximately.

TABLE I

Multiplets in Te II

| 5p | $^4S_{1\frac{1}{2}}$ 173801 | *10221* | $^2D_{1\frac{1}{2}}$ 163580 | *2733* | $^2D_{2\frac{1}{2}}$ 160847 | *8536* | $^2P_{\frac{1}{2}}$ 152281 | *4180* | $^2P_{1\frac{1}{2}}$ 148101 |
|---|---|---|---|---|---|---|---|---|---|
| $6s\,{}^4P_{\frac{1}{2}} = 95352{\cdot}6$ | 78447(10) | | 68225(3) | | — | | — | | — |
| *4295·1* | | | | | | | | | |
| $^4P_{1\frac{1}{2}} = 91057{\cdot}5$ | 82742(10) | | 72519(4) | | — | | — | | — |
| *3353·1* | | | | | | | | | |
| $^4P_{2\frac{1}{2}} = 87704{\cdot}4$ | 86094(6) | | — | | — | | — | | — |
| $^2P_{\frac{1}{2}} = 89246{\cdot}1$ | — | | 74334(10) | | — | | 63035(10) | | — |
| 3870·3 | | | | | | | | | |
| $^2P_{1\frac{1}{2}} = 85375{\cdot}8$ | 88425(4) | | 78204(3) | | 75471(8) | | 66905(4) | | 62724(5) |
| $^2D_{1\frac{1}{2}} = 78944{\cdot}4$ | 94862(5) | | 84635(6) | | 81901(3) | | — | | 69153(3) |
| $\alpha = 71559$ | 102245(9) | | 92023(6) | | — | | 80717(1) | | 76538(6) |
| $\beta = 83810$ | | | 79767(3) | | 77036(9) | | — | | — |

TABLE I (*contd.*)

Multiplets in Te II

| 6p / 6s | $^4D_{\frac{1}{2}}$ | $^4D_{1\frac{1}{2}}$ | $^4D_{2\frac{1}{2}}$ | $^4D_{3\frac{1}{2}}$ | $^4P_{\frac{1}{2}}$ | $^4P_{1\frac{1}{2}}$ | $^4P_{2\frac{1}{2}}$ | $^4S_{1\frac{1}{2}}$ | $^2D_{1\frac{1}{2}}$ | $^2P_{\frac{1}{2}}$ | $^2P_{1\frac{1}{2}}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *1647·4* | *6295·8* | | | *2632·9* | *4011·4* | | | | *5212·0* |
| | 74458·6 | 72811·2 | 66515·4 | | 77008·9 | 74376·0 | 70364·6 | 65461·6 | 71733·8 | 73362·4 | 68150·4 |
| $^4P_{\frac{1}{2}}$=95352·6 | 20893·9(5) | 22541·6(5) | — | — | 18343·2(10) | 20976·0(7) | — | 29891·3(1) | — | 21991·4(5) | — |
| *4295·1* | | | | | | | | | | | |
| $^4P_{1\frac{1}{2}}$=91057·5 | 16598·8(1) | 18245·8(6) | 24541·7(8) | — | 14048·2(2) | 16681·2(6) | 20692·6(10) | 25596·3(1) | — | 17696·4(10) | 22908·1(9) |
| *3353·1* | | | | | | | | | | | |
| $^4P_{2\frac{1}{2}}$=87704·4 | — | 14892·3(1) | 21188·0(1) | — | — | — | 17339·5(5) | 22243·6(6) | 15971·4(3) | — | 19555·6(3) |
| $^2P_{\frac{1}{2}}$=89246·1 | — | 16436·1(3) | — | — | — | 14870·0(0) | — | — | 17513·2(10) | 15884·6(7) | 21097·0(3) |
| *3870·3* | | | | | | | | | | | |
| $^2P_{1\frac{1}{2}}$=85375·8 | — | — | 18860·7(4) | — | — | — | 15011·5(2) | 19912·8(2) | — | — | 17227·4(6) |

A comparison of the intervals of the deepest terms in the iso-electronic spectra of Sb I[4] and Te II and of As I[5] and Se II[6] is shown in Table II. It provides strong evidence of the correctness of the identification. The usually expected regularity among the term intervals is obvious from the Table.

TABLE II

Term Intervals

| Term Interval | As I | Se II | Sb I | Te II |
|---|---|---|---|---|
| ms $^4P_{\frac{1}{2}}$-$^4P_{1\frac{1}{2}}$ | 915·8 | 1483·6 | 2696·0 | 4295·1 |
| $^4P_{1\frac{1}{2}}$-$^4P_{2\frac{1}{2}}$ | 1287·8 | 1920·7 | 2387·4 | 3353·1 |
| $^2P_{\frac{1}{2}}$-$^2P_{1\frac{1}{2}}$ | 1469·6 | 2459·7 | 2400·0 | 3870·3 |
| mp $^2P_{\frac{1}{2}}$-$^2P_{1\frac{1}{2}}$ | 461·2 | 858 | 2068·8 | 4180 |
| $D_{1\frac{1}{2}}$-$^2D_{2\frac{1}{2}}$ | 322·3 | 616 | 1341·6 | 2733 |
| ms $^4P_{2\frac{1}{2}}$-$^2P_{\frac{1}{2}}$ | 237·7 | 222·0 | —1341·8 | —1541·7 |

REFERENCES

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6 Krishnamurty and K. R. Rao, *Proc. Roy. Soc., A*, **149**, 56 (1935).