The Spectra of Silicon at Successive Stages of Ionisation.[1]

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THE present lecture may be regarded as a continuation of the Bakerian Lecture of 1914, in which it was established that series in spark spectra, though otherwise similar to arc series, are characterised by a fourfold value of the series constant N. This result was in complete agreement with Bohr's theory, according to which arc series originate in neutral atoms, and spark series in ionised atoms. The theory further suggested that atoms which had lost two electrons, or had become doubly ionised, would give series having 9N for the constant; atoms which had lost three electrons would yield series with 16N for constant, and so on.

In a search for spectra of the higher orders, one of the most promising elements appeared to be silicon, which Sir Norman Lockyer had already shown to be represented by different groups of lines in stars of successively higher temperatures. The spectra obtainable from this element under the action of discharges of increasing intensity have accordingly been investigated over the long range of spectrum necessary for the investigation of series relationships. The results of the inquiry are in accordance with theoretical prediction so far as the fourth spectrum.

Theoretical expectations in regard to the relations between these spectra and those of elements which immediately precede silicon in the periodic table have also been realised, the necessary additional data for a full comparison being provided by Paschen's recent work on the second and third spectra of aluminium. The relations between the various spectra may conveniently be indicated as follows:

	Doublets.	Triplets.	Doublets.	Triplets.
$n=1$	Na I	Mg I	Al I	Si I
C=N	11+, 10 −	12+, 11 −	13+, 12 −	14+, 13 −
$n=2$	Mg II	Al II	Si II	
C=4N	12+, 10 −	13+, 11 −	14+, 12 −	
$n=3$	Al III	Si III		
C=9N	13+, 10 −	14+, 11 −		
$n=4$	Si IV			
C=16N	14+, 10 −			

$$\text{Series constant} = C = \frac{2\pi^2 e^2 m}{ch_3} \cdot \frac{M}{M+m} \cdot (ne)^2.$$

Under each symbol the number preceding the + sign represents the nuclear charge, and that preceding the − sign the number of external electrons in addition to the one which generates the spectrum, so that in the first row the atoms as a whole are neutral. All spectra in the same vertical column have been found to be similar, but as n increases, corresponding lines are of higher frequencies, and the doublet or triplet separations are increased.

The principal numerical data, some of which are of immediate importance in connexion with work on the temperatures of the hotter stars, are included in the following brief references to the four spectra of silicon.

[1] Substance of Bakerian Lecture of the Royal Society delivered on Thursday, May 15.

Si I.—Theory suggests that new features will be presented by this spectrum, inasmuch as the effective electron probably traverses a 3_2 orbit; a p or P term may therefore be expected for the highest limit, and not an S term as in Mg I. The triplets are very feebly developed, there being but one representative of each of the s and d series. From analogy with other triplet spectra, however, the limit $3p_2$ may be expected to be in the neighbourhood of 85000. Six singlets which are reversed in the arc can be arranged in two series of subordinate type converging near to 60000, which may be taken as the value of 3P. If the resonance line $3p_2 - 3P$ be $\lambda 3905$ ($\nu 25598$), as is not improbable, the term $3p_2$ will be 85600, in close accordance with the first estimate. Further work on this spectrum is necessary, but the resonance and first ionisation potentials may provisionally be taken as 3·2 and 10·6 volts respectively. Some of the strongest lines of the arc spectrum form two multiplets of the pp' type.

Si II.—The spectrum forms a doublet system analogous with that of Al I, and the various constituent series are well represented. Lines at $\lambda\lambda 1533{\cdot}55$, $1526{\cdot}83$ ($\nu\nu 65208$, 65495) form the leading pair of the sharp series, the limits of which are $3\pi_1 = 131531$, $3\pi_2 = 131818$. The resonance potential is therefore 8·09 volts and the second ionisation potential 16·27 volts. Besides the usual sets of terms, there is a double term of d type, $x_1 = 76498$, $x_2 = 76514$, which yields a strong series of fundamental type in the far ultra-violet; no corresponding terms have been noted in aluminium.

Si III.—The spectrum is of the same type as that of Al II and Mg I, consisting of triplets and singlets. The first line of the first d triplet is at $\lambda 1113{\cdot}76$, and that of the first s at $\lambda 997{\cdot}7$. The limits of the triplet series are $3p_1 = 216879$, $3p_2 = 217142$, $3p_3 = 217273$. The singlet series have not been certainly identified, but there is evidence that the resonance line $3S - 3p_2 = \nu 39330$, and the first principal line $3S - 3P = \nu 82857$. If so, the resonance potential will be 4·85 volts, and the third ionisation potential 31·66 volts ($3S = 256472$).

Si IV.—Additional lines of the doublet system of Si IV have been photographed by Millikan in the extreme ultra-violet, but the series limits previously published are not materially modified. The resonance lines are $\lambda\lambda 1393{\cdot}9$, $1402{\cdot}9$ ($\nu\nu 71740$, 71280), indicating a resonance potential of 8·86 volts. The fourth ionisation potential is 44·95 volts.

The ionisation potentials, and the doublet or triplet separations of elements in the same column of the foregoing table, are more simply related than those of elements in corresponding columns of the periodic table.

International Congress on Applied Mechanics.

THE International Congress on Applied Mechanics, held at Delft during the last week of April, was an extremely successful gathering of about two hundred scientific men drawn from all parts of Europe and America for the discussion of papers covering a wide range of subjects, which may be roughly classified as dealing with the theory of elasticity and recent researches in plasticity, hydrodynamics, and aerodynamics. It was mainly due to the energy and organising ability of the chairman, Prof. Biezeno, and secretary, Prof. Burgers, that the meeting was such a pronounced success.

Delft is an admirable centre for a congress on applied science, as it is the focus of most of Dutch activity in this field, with an extensive range of buildings and laboratories in which teaching and research work go on side by side.

The Dutch contributions to the fifty or more papers presented were naturally a prominent feature and included a very interesting theoretical paper, by Prof. Biezeno, on graphical and numerical stress determinations in beams and plates, a paper on the motion of a fluid in the boundary layer along a plane surface, by Dr. Burgers, forming an extension of