## LETTERS TO THE EDITOR.

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### Spectral Series in Relation to Ions.

As I have already shown (*Physik. Zeitschr.*, vi., 892, 1905), the observation of the Doppler effect on the Kanal-strahlen permits the detection of spectra emitted by the positive ions (Kanal-strahlen). I have made such researches on Kanal-strahlen in hydrogen, potassium vapour, and mercury vapour in cooperation with Messrs. S. Kinoshita, K. Siegl, and W. Hermann. We shall give details of our methods and measurements in separate papers; but here I wish to state the principal results of the researches, together with some general conclusions.

The series of lines (H$\alpha$, H$\beta$ . .) of hydrogen is a first subordinate series. Its lines are revealed by accurate analysis as pairs or doublets. The difference of wave-lengths of the two components is, as Michelson has found (*Phil. Mag.*, xxxiv., 280, 1892), 0·14 Ångström unit for H$\alpha$ and 0·08 Ångström unit for H$\beta$; the measurements made by Ebert (*Wied. Ann.*, xliii., 790, 1891) give 0·132 Ångström unit for H$\alpha$. In every other first subordinate series of doublets, and also in the case of hydrogen, the difference in oscillation frequencies of the components of the doublet is constant throughout the series; this difference is for H$\alpha$ 0·33, for H$\beta$ 0·34 per 1 cm. path *in vacuo*. My previous and recent observations lead to the conclusion that the first subordinate series of doublets of hydrogen has as carriers monovalent positive atom-ions, *i.e.* atoms of hydrogen which have lost a single negative electron.

A second subordinate series of lines of the hydrogen has been observed in certain stars. From their spectral position, Rydberg (*Astrophys. Journ.*, vi., 233, 1897) has calculated the principal series of hydrogen; he gives to the first line of it the wave-length 4687·88 Ångström; this line has been observed in stars with bright lines. It is found also (somewhat displaced) in all spectrograms I have taken of the kathode rays or Kanal-strahlen, partly alone and partly in cooperation with Mr. Kinoshita. This line of the principal series—it may be termed H$\beta$—shows also the Doppler effect in the Kanal-strahlen, the quantity of the effect being the same as for the first subordinate series of doublets; the principal series of the hydrogen, which is also composed probably of doublets, has therefore the same carrier as the first subordinate series, namely, the monovalent positive ion of hydrogen.

In cooperation with Mr. Siegl I have further examined another doublet of a principal series, namely, the second doublet of the principal series of potassium ($\lambda$ 4047·36–4044·29). Both components show the Doppler effect in the Kanal-strahlen, and the amount is the same as that calculated for an atom of potassium which has lost a single negative electron. Therefore, in the case of the alkali-metals also, the principal series of doublets has monovalent positive ions as carriers.

In the spectrum of mercury hitherto only series of triplets have been found—a first and a second subordinate series (Kayser and Runge). Using a small concave grating kindly lent to me by Prof. Runge, I succeeded, in cooperation with Mr. Hermann, in examining the Doppler effect on the lines of mercury. It was found that all components of triplets, and further all triplets of a series, have the same positive ion as carrier, and, moreover, the lines of the first and of the second series show the same Doppler effect in type and quantity. Both series of triplets of mercury have therefore the same carrier, the bivalent positive ion of mercury; for the Doppler effect really found agrees in quantity with the effect calculated theoretically for an atom of mercury which has lost two negative electrons.

The lines of mercury not belonging to the series of triplets show likewise a Doppler effect, but there is a difference in character and amount between them and the lines of the two series of triplets. There are lines which show a larger effect than the series of triplets; the carrier of these lines is therefore a positive ion of mercury of higher valency, *i.e.* an atom of mercury which has lost more than two negative electrons. To these lines of higher valency belongs the line $\lambda$ 4078·1.

Finally, there are lines in the spectrum of mercury which show a smaller Doppler effect than the lines of the series of triplets; their displacement is roughly 1·5 times smaller than that of a line of a triplet of equal wave-length. Therefore they have as carrier not a bivalent, but a monovalent positive ion of mercury. To these lines belong the wave-lengths $\lambda\lambda$ 2536·72, 4339·47–3021·64, 3984·08–2847·85. It seems that $\lambda$ 2536·72 is the first component of a principal series of doublets, that the pair $\lambda\lambda$ 4339·47–3021·64 belongs to a first, and the pair $\lambda\lambda$ 3984·08–2847·85 to a second subordinate series of doublets. This being so, mercury confirms the view that the principal and the first and second subordinate series of doublets have monovalent positive ions as carriers.

Generalising the foregoing results, we have come to the following conclusions:—The carriers of the spectra of lines of the chemical elements are positive atom-ions. All lines of a series have the same carrier, and, moreover, the same carrier may emit several series at the same time. The carrier of the principal series and of the subordinate series of doublets is a monovalent positive atom-ion; the carrier of the subordinate series of triplets is a bivalent positive atom-ion; ions of a higher valency emit likewise line spectra, but the structure of these is not yet recognised. The spectrum of an element, for example, that of mercury, may represent a mixture of several spectra, namely, of the spectra of its monovalent, bivalent ions, and of ions of higher valency.

The foregoing results and conclusions are in striking agreement with the results which were arrived at by Runge and Paschen (*Ber. d. Berliner Akad.*, 1902, 380, 720) in their researches on the Zeeman effect of series of lines. They found that the principal series of doublets of all elements examined (Na, Cu, Ag, Mg, Ca, Sr. Ba) show in type and amount, when measured in oscillation frequencies, the same Zeeman effect; this also holds good for the first and the second series of doublets. The first and second subordinate series of triplets show in type and amount another Zeeman effect than the series of doublets; but the series of triplets of different elements are again in the same way broken up by a magnetic field. The agreement of my results with those of Runge and Paschen comes out in the following detail:—The lines of mercury ($\lambda\lambda$ 2536·72, 4339·47, and 2847·85) referred by me to series of doublets must show in a magnetic field the known splitting up of the lines of the principal and of the subordinate series of doublets. Runge and Paschen enumerate these lines under those which do not show the behaviour of triplets, and, in fact, their statements on the magnetic behaviour of those lines are concordant with that postulate.

It follows from the Zeeman effect that the centres of emission of series of lines are periodically accelerated negative electrons. From the complexity of their magnetic splitting up we may draw the conclusion that these centres of emission—the negative electrons—are coupled in electrodynamic systems; the electrodynamic structure of these systems of negative electrons is for the emission of series of doublets rather than for the emission of series of triplets.

We do not know of spectra of neutral atoms. It follows from the foregoing results that the known spectra of lines can only be emitted if the chemical neutral atoms have lost negative electrons, and thus have become positive atom-ions. Therefore the electrodynamic symmetry of the system of negative electrons in the positive atom-ion is different from the symmetry in the neutral atom. Certain systems of negative electrons have in the positive monovalent ion an electrodynamic symmetry which enables them to emit radiation of electromagnetic energy; this symmetry is characterised by the emission of doublets. Losing two or more negative electrons a neutral atom also gains an electrodynamic symmetry capable of radiation; but the electrodynamic symmetry in the bivalent ion is different from that in the monovalent ion; it is characterised by the emission of triplets.

Spectroscopically the chemical elements show a uniform behaviour in a striking way. Their monovalent ions emit series of doublets of analogous structure and identical magnetic behaviour; their bivalent ions emit series of triplets likewise of analogous structure and identical magnetic behaviour. From element to element the variables are only the proportions of the spectra or the constants of the laws of the series of doublets and triplets.

Göttingen, March 5. J. STARK.

### The Kew Bulletin.

A FEW words of explanation may be useful to anyone interested in the Kew Bulletin. It was started in 1887, partly to meet a suggestion made in the House of Commons and partly to serve as "an expeditious mode of communication to the numerous correspondents of Kew in distant parts of the Empire." It has been the vehicle for the publication of a vast amount of information of various kinds, some on purely scientific, but mostly on economic subjects. The number of copies printed has necessarily been limited, but it has always been hoped that the Press would aid in the further diffusion of information of general interest to the public.

The volumes before 1892 have long been out of print. To meet this difficulty, selected papers which proved to be of permanent interest have been from time to time reprinted.

Since 1901 the Bulletin has been somewhat in abeyance, though the routine appendices which are required for various purposes have been kept up. The fact is that to produce the Bulletin satisfactorily requires—what it has never had—some sort of staff which would be specially charged with it. The volume of work which falls on Kew is little understood. Besides its own routine and administrative duties, Kew acts as technical adviser to all Government departments at home, as well as in a varying measure to India and the colonies. For many years the annual number of letters sent out has averaged about 14,000, which is about two-thirds of that of the Commercial Department of the Foreign Office. The publication of the Bulletin has simply been crowded out.

My functions as director ceased on December 15, but I was retained in a consultative capacity until March 31. In order to give my successor a clear start I have done my best in the interval to clear off arrears. The third and concluding volume of the "Index Floræ Sinensis" has been issued. An eighth volume of the "Flora of Tropical Africa" has been all but passed through the press. The long delayed "Wild Fauna and Flora of the Royal Botanic Gardens" has been published. A catalogue of the exhibited collection of portraits of botanists has been prepared and is in type, and a second edition of the "Hand-list of Ferns and Fern-allies cultivated at Kew" is in the printers' hands. A third quinquennial supplement to the "Index Kewensis" is being prepared for the press.

The continuation of the "Flora Capensis" is being actively pushed forward, and other much needed undertakings are in view.

In order to restore the Bulletin to something like vitality, it was thought advisable to issue in one or more numbers for each year such matter as was available, with title and table of contents. This will allow the annual volumes to be bound, and the series made continuous to the satisfaction of careful librarians. The volumes for 1900 and 1901 are already issued, and the succeeding ones will follow immediately. A word of acknowledgment must be given to the generous aid of the new and active Controller of H.M. Stationery Office in expediting the work.

The director has taken up the publication of the Bulletin from the present year, and will, I hope, be able to continue it, but on a somewhat more elastic plan. No attempt will be made to issue it monthly, but material and documents of general interest will be printed at once.

Kew, March 30. W. T. THISELTON-DYER.

### Interpretation of Meteorological Records.

I QUITE agree with Mr. Omond's remarks in NATURE of March 29 with regard to the heating of downward moving air, that if it had been simply a case of air which had previously been in thermal equilibrium and moved downwards its temperature would have been raised to that of the lower air; but in this case it was a mixture of air and water; and the water would absorb the heat produced by the compression of the air, and, further, any little heating that might not be so absorbed would increase the dryness of the air, and so cause evaporation and absorption of heat.

With regard to the effects of electricity on rainfall, they are much too little understood to be entered on here, but it may be stated that a sudden fall of rain, or an increase in rate of fall, is often observed very shortly after a flash of lightning. JOHN AITKEN.

Ardenlea, Falkirk, N.B., March 31.

### Request for Prints of Photographic Portraits.

I SHOULD be grateful to your photographic readers, whether amateur or professional, who would send me, within the next two or three weeks, waste photographic portraits, to be cut up, mounted, reduced to a miniature scale, and so to be published *without names*. They are wanted in considerable numbers to control results at which I have already arrived, relating to resemblance. Family portraits would be particularly acceptable. I make this appeal, finding it extremely troublesome, as well as costly, to obtain the needed material in other ways. FRANCIS GALTON.

42 Rutland Gate, London, S.W.

### Peculiar Ice Formation.

As the question of earth-bearing ice-pillars has been recently raised in your columns (pp. 464, 485), there are one or two points to which I should like to direct attention, as they may be of interest to your readers. While working in company with a colleague on Divis Mountain, Belfast, in 1902, our attention was attracted by the peculiar formation of ice so admirably described by your correspondent of March 15. It seemed perfectly obvious that the ice-pillars had, in growing, lifted the earth and stones by exerting a pushing force in the direction of their length, and that without lateral support, putting the expansive force of water on freezing out of the question as an explanation. All doubt on this point was removed by our finding an impression of a nailed boot, made in the mud before the frost, and on which the pillars had grown on all parts of the mud on which there were no impressions of nails, and were wanting wherever the nails had been. This gave a curious effect, as if the boot had been shod with long spikes, each nail being represented by a narrow cylindrical pit an inch and a half deep. The pressure of the nails had evidently destroyed the conditions which led to the formation of the pillars.

I was unable to determine whether the ice in each pillar was in crystalline continuity, but there was nothing to lead one to suspect the contrary. I thought I could distinguish a rude hexagonal form in some of the pillars, but this may have been merely chance. On the whole, it would seem as if the idea that a growing crystal is capable of exerting a mechanical force in some definite direction is not entirely without support. Such a force would go far towards explaining many peculiarities of the natural growth of crystals. Take, for example, the horizontal veins of fibrous gypsum so common in the Keuper Marl. It is impossible to conceive of the formation in soft rocks of a horizontal fissure of the extent of some of these veins, and it is difficult to escape from the conclusion that the growth of the fibrous crystals forced apart the sides of the vein, lifting the enormous weight of rock above. This suggestion is by no means a new one.

W. B. WRIGHT.

28 Jermyn Street, S.W., March 27.