

remain in substance unaltered. At the same time the elaboration of the theoretical considerations sketched in this letter throws a good deal more light on the interpretation of many details. For instance, it is possible to account for the appearance in the atom, with increasing atomic number, of groups of new constitution in such a way that we obtain a natural interpretation not only, as before, of the existence of such families of elements in the periodic table as those of the iron metals and the rare earths, but also of the almost complete absence of any effect on the Röntgen-ray spectra of the appearance of such groups. This absence is explained by the fact that in these families we do not witness any sudden change with increasing atomic number in the total number of quanta of the orbits of the electrons of certain groups. On the contrary, we may be assumed to witness in the appearance of each of these families the completion of a group by the inclusion of further electrons moving in orbits characterised by the same number of quanta. This addition to the group is brought about by a change in the interaction between the various possible types of orbits with this number of quanta caused by the alteration in the dimensions of the orbital loops and in the "apparent" number of quanta which may be said to characterise these loops.

I have confined myself here to these points of general character. For details of the theory and its applications I must refer the reader to a paper in preparation for publication by the Royal Danish Academy of Science.

N. BOHR.

Copenhagen, September 16.

The Separation of Chlorine into Isotopes.

IN NATURE of April 22, 1920 (vol. 105, p. 230) Harkins and Broeker reported that they had obtained a partial separation of the element chlorine into isotopes. Five determinations made early in February of that year showed atomic weight increases of 0.052, 0.059, 0.057, 0.055, and 0.053 unit of atomic weight. Assuming that ordinary chlorine has an atomic weight equal to 35.460, the new chlorine as separated had an atomic weight equal to 35.515.

Shortly after the publication of this report in NATURE the progress of the separation was stopped by the death of Mr. Broeker. Soon after this an entirely independent diffusion was begun by Dr. Anson Hayes and the present writer, using new apparatus and a different source for the hydrogen chloride. In this way about twenty grams of chlorine which has an atomic weight higher by 0.0375 unit than that of ordinary chlorine, and eighty grams with an atomic weight higher by 0.034 unit, have been obtained, together with several kilograms the atomic weight of which has not been determined, but must be more than 0.2 unit high in order to give the results cited above. Thus far the effort has been to collect considerable material for future work rather than to get the maximum increase of atomic weight. The details of this work were reported to one of the American chemical journals in April of this year, but publication may be delayed many months by a strike of the printers.

The atomic-weight method used gave results accurate to 0.003 unit of atomic weight, and consisted in determining the amounts of acid in samples of ordinary and isotopic hydrochloric acid of the same density. The pycnometer was made in such a way as to give high precision, and the thermostat was regulated to 0.001°. Eighteen atomic-weight determinations were made.

Absence of impurities, and especially of bromine

and iodine, was ensured by using only the purest materials in the diffusion in an apparatus consisting of glass and porous porcelain only, and by recrystallising the chlorine from water in the form of sodium chloride three times and by precipitating it once in the same form by passing in isotopic hydrogen chloride gas. In addition to this, two fractional distillations with potassium permanganate and one fractional distillation without this substance were used.

Mr. T. H. Liggett, who worked with the present writer on this problem in the year 1917-18, has reported that he also has secured an increase of 0.05 in the atomic weight of chlorine by using the same method—the diffusion of hydrogen chloride gas.

Thus we have definitely confirmed the separation reported by Harkins and Broeker.

WILLIAM D. HARKINS.

University of Chicago, August 28.

The Pickering Series in O Type Stars.

IF the Pickering series, consisting of the lines 5411, 4542, 4200, etc., in stellar spectra, is due to ionised helium, it is known from the investigations of Fowler and from Bohr's theory that there must be additional lines which appear as violet components of the Balmer series of hydrogen. As these components have an average separation of 2 Å. they should be readily seen in the spectra of O type stars. Unfortunately, there are two unfavourable circumstances: first, the O type stars are all faint, and, secondly, the lines of both the Balmer and the Pickering series are in general so diffuse as to be hopelessly blended.

A preliminary survey was made here last year of O type stars for the purpose of selecting one or more stars of reasonable brightness and with fairly sharp lines. As a result 10 Lacertæ, type Oe 5, magnitude 4.9 was selected as the most suitable star for tests with higher dispersion. On resuming work this year the director, Dr. J. S. Plaskett, directed attention to 9 Sagittæ, type Oc, magnitude 6.2, as also a very suitable star. After some preliminary experiments, two plates of 9 Sagittæ and 10 Lacertæ with three-prism dispersion (10 Å. to 1 mm. at H γ) were secured on August 12 which showed components at H β and H γ at the theoretical separation. With this as a start, check plates were secured, and in addition high dispersion plates, requiring 9-10 hours' exposure were secured of the region around H α in 10 Lacertæ. The preliminary wave-lengths on the international scale of the complete Pickering series, and also of the Balmer series, are summarised in the following table:—

Pickering series.		Balmer series.	
Star.	Computed.	Star.	Star-Lab.
6559.71 ¹	6560.15	6562.79 ¹	±.00
5411.54	5411.53		
4859.07 ²	4859.35	4861.34	+ .01
4541.65	4541.62		
4338.77	4338.70	4340.45	- .02
4200.00 ³	4199.86		
4099.96	4100.00	4101.70	- .04

¹ The wave-length of H α was assumed in order to determine the position of the other component. Measures of the H α component were difficult to make, partly on account of the small linear dispersion and partly because of the existence of a line 6558.6, origin unknown.

² Blend with Fowler's enhanced nitrogen line 4858.82 in 10 Lacertæ. In 9 Sagittæ there is no component, as it is probably obliterated by the enhanced nitrogen line appearing as emission.

³ Blend with Fowler's enhanced nitrogen line 4200.06.