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Physics. — *A new isotope of Argon.* By P. ZEEMAN and J. DE GIER.

(Communicated at the meeting of February 24, 1934).

Argon was one of the first elements analysed by ASTON with his mass spectograph. It gave a very strong line at 40, relative to hydrogen.

A lighter isotope gives a very faint line corresponding to a mass 36. The proportion of A^{36} was estimated by ASTON to be less than 1 % [1].

Already in the beginning of the last year we tried to apply our apparatus, arranged according to J. J. THOMSON's original parabola method of analysis, for a careful search to disclose new isotopes. THOMSON's method is pre-eminent in respect to the range of information it provides.

In the spring of 1933 argon was examined [2]. Besides the parabolas for the isotopes 40 and 36, a faint parabola 38 was obtained. At the time diverse interpretations of this result were possible.

In the course of 1933 certain improvements were included in the apparatus, so that we expected to attain more definite results.

In the first place a very intensive canal ray bundle in the discharge tube is necessary. The form of the surface of the kathode and of the front surface of the first slit is in this respect of great influence.

Next the dimensions of the slits had to be chosen with some care. If the bundle, limited by the slits is not intensive enough, then one cannot by increasing the current strength of the discharge or by prolonging the time of exposition, augment in an arbitrary degree the photographic density.

In argon, and in neon as well, the material of the cathode is largely sputtered. The wall of the tube becomes coated with the material from the cathode and more rapidly with increase of current density. The now conducting wall of the tube assumes the role of the cathode. The bundle becomes insufficiently concentrated and the aperture of the slit is no longer reached.

At the same time the discharge becomes irregular and one is obliged to open the tube and to clean off the coating. By diluting the inert gases

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1) F. W. ASTON. Mass-Spectra and Isotopes. 1933.

2) P. ZEEMAN and J. DE GIER. These Proceedings 36, 609. 1933.

with oxygen the sputtering can be diminished. Of course the number of argon ions in the bundle is diminished simultaneously. It appeared to be possible to choose the current intensity so low, that without diluting with much oxygen the gas discharge remained steady.

The slits must be rather wide for obtaining the desired photographic density with reasonable time of exposure.

Of course a too great width of the slits would impede the vacuum in the body of the camera [1]).

With these precautions good photographs with Argon were obtained. Between the parabolas for the isotopes A^{40} and A^{36} always a parabola for the mass 38 was obtained. The intensity of the 38 parabola relatively to that of the two other ones remained unchanged by diluting with O_2, N_2, and other gases.

Special attention was given to those series of parabolas of hydrocarbons, due to traces of grease. By diluting the argon with oxygen we easily obtained photographs where the hydrocarbons were absent.

Hence it follows that molecular combinations such as C_3H_2, C_2N etc. were excluded for the explanation of the 38 parabola.

Atoms of mass 38 were till now unknown. We therefore infer, that 38 is really due to a new isotope of argon.

A welcome confirmation, demonstrating the advantages of THOMSON's parabola method, we find in the following.

The noble gases, as neon and argon, exhibit often multiply charged ions. Thus argon shows on several of our photographs as many as five positive charges.

Oxygen, carbon and nitrogen less. Molecules however generally still less [2]).

Fig. 1 : The reproduction of one of our photographs shows the argon 40 parabola with different prolongations to $\frac{1}{4}$ at least of the original distance of the head of the parabola to the axis.

Hence there are many argon (40) ions carrying a twofold charge in the discharge tube, but which have lost one of these charges after passing through the cathode.

The number of ions having threefold charge in the discharge tube but having received two electrons is much less and so on.

The parabola 36 is also clearly prolongated. From the behaviour of the A^{40} ions it was to be expected that also many A^{36} ions would have been doubly charged.

It is now important to remark that a study of plates with parabolas 38 revealed the existence of a faint but real prolongation to $\frac{1}{2}$ of the distance to the axis. The reproduction shows a trace of it.

The identity of the ions 38 is now undoubtedly proved. The very feeble

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[1]) P. ZEEMAN and J. DE GIER. l. c. 910.

[2]) R. CONRAD, Phys. Z. S. 31, 888, 1930.

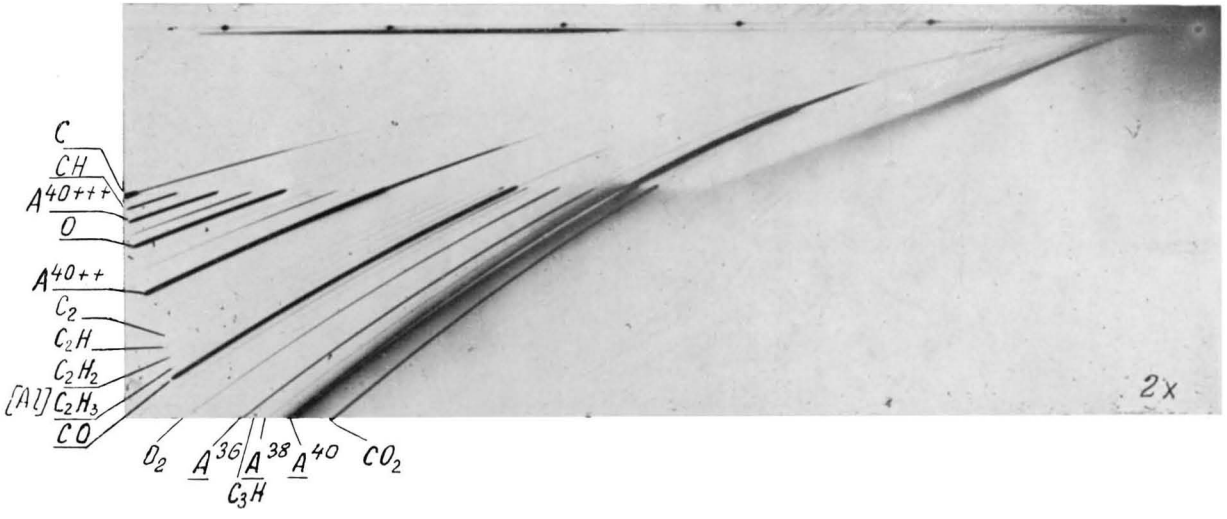

Fig. 1

parabola gives a prolongation which would certainly be absent in the case of a molecule of that intensity.

It is an inert gas ion. Argon possesses also the isotope A^{38}.

We generally find that the prolongations considered are accompanied on the same plate with second order parabolas due to particles which have retained their double charge after passing through the cathode. The A^{40++} is very strong and even prolongated.

The A^{36++} and A^{38++} parabolas coincide with OH_2^+ and OH_3^+, which are difficultly to repress.

Finally the parabola A^{40+++} may be faintly seen [1]). On some others of our plates this parabola is much stronger and also prolongated.

It is to be regretted that our reproduction exhibits some series of hydrocarbons. The series generally exhibit a number of parabolas of which the intensity is rather equal in each series.

We may infer that 36 and 38 are only in an extremely small degree "falsificated" by C_3 or C_3H_2. The parabola 37 of C_3H can be hardly seen.

From plates where the hydrocarbons were entirely absent we could by variation of the time of exposure conclude to an intensity of the 38 parabola equal to $^1/_5$ à $^1/_{10}$ of the 36 parabola.

The parabola 40 is in the reproduction nearly entirely solarised, moreover overlaps the 41 parabola $A^{40}H$.

Finally on some plates, where the hydrocarbons are absent, a very faint line 37 was discovered.

Very probably this is due to $A^{36}H$, the hydride of the isotope A^{36}, as proved by dilution with hydrogen.

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[1]) In the figure the parabola 14 is abusively indicated as A_{40}^{+++}. The place of A_{40}^{+++} is $13^1/_3$. It can hardly be seen here.

For convenience the + sign is omitted for the singly charged ions.

On the right of the photograph a faint parabola is visible, which corresponds to a mass 80. It will be caused by a argon molecule ion A_2^+. Still farther to the right is a short parabola due to Hg.

Mathematics. — *Eine Abbildung der Kongruenz der kubischen Raumkurven durch vier Punkte, welche eine vorgegebene Gerade zweimal treffen.* Von JAN DE VRIES.

(Communicated at the meeting of February 24, 1934).

§ 1. Die kubischen Raumkurven ϱ^3 durch die Punkte C_1, C_2, C_3, C_4, welche die Gerade b je zweimal treffen, bilden eine Kongruenz. Eigen-