probable that the impurity which was present in small quantities in the maltose preparations would be a fermentable sugar. It was therefore decided to purify the maltose by adding to a 10 % solution a suspension of a glucose — but not maltose — fermenting yeast. As such *Saccharomyces Marxianus* was used. After four hours incubation at 30° C. the yeast cells were separated from the maltose solution by filtration through a Seitz filter. The sterile filtrate was then used for a new series of respiration experiments.

TABLE 4.

Purified maltose against crude maltose as a substrate for the respiration of Saccharomyces Marxianus and of Saccharomyces exiguus.

	Saccharomyces Marxianus	Saccharomyces exiguus
	Q_{O_2}	Q_{O_2}
Without sugar	29.1	27.0
10 % maltose (Merck)	89.4	90.2
10 % maltose purified	30.8	36.4

As will be seen from Table 4 the rate of respiration of both species in the purified maltose solution is practically identical with that in the absence of sugar.

We may therefore conclude that pure maltose is unsuitable as a substrate for the respiration of *Saccharomyces Marxianus* and *Saccharomyces exiguus*.

Herewith the arguments given by TRAUTWEIN and WEIGAND in favour of the dualistic theory of respiration and fermentation have been refuted.

Physics. — *Preliminary note on some experiments concerning isotopes of some of the noble gases and hydrogen by means of* J. J. THOMSON's *mass spectrograph.* By P. ZEEMAN and J. DE GIER.

(Communicated at the meeting of June 24, 1933).

Sir JOSEPH THOMSON's beautiful parabola method, the original method of positive ray analysis depending on the use of parallel magnetic and electric fields has been much refined by ASTON but has still some advantages of its own.

We have built a mass spectrograph according to the original THOMSON pattern with some improvements according to CONRAD[1]) and some slight modifications of our own necessitated by our purpose in view: the determination of the different kinds of atoms and molecules in the discharge tube with only short expositions.

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

A more detailed description must be reserved for a future communication.

Some photographs were made with the inert gases *He*, *Ne*, and *Ar*. Besides the well known parabolas, rather weak ones were observed for $\frac{m}{e} = 5{,}23$ and 41. They are probably due to hydrides of the inert gases, according to a suggestion of Sir J. J. THOMSON [2]) and seconded by ASTON [3]) [4]). We studied these hydrides under various circumstances, and intend to return to the subject. [4a])

Prof. KEESOM [5]) was kind enough to supply us with a sample of a mixture of hydrogen isotopes. The sample contained 3% of $H^1 H^2$ molecules. With our rather wide slits a parabola $\frac{m}{e} = 4$ was obtained after a very short time of exposure. A new parabola $\frac{m}{e} = 5$ was observed after an illumination of about 40 minutes. The $\frac{m}{e} = 4$ corresponds to the $(H_2^1 H^2)^+$ ion, the $\frac{m}{e} = 5$ corresponds to a $(H^1 H_2^2)^+$ ion. A parabola $\frac{m}{e} = 6$ is to be expected; it would correspond to a $(H_3^2)^+$ ion, but the probability for the formation of a triatomic hydrogen ion of heavy atoms only, is so small, that we have not to be astonished that a three hours exposition does not show any trace of the $\frac{m}{e} = 6$ parabola. [6])

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[2]) J. J. THOMSON. Proc. Royal Soc. **99**, 90, 1921.

[3]) F. W. ASTON. Isotopes 1924, pag. 117.

[4]) H. LUKANOW und W. SCHÜTZE. Z. S. f. Phys. **82**, 610. 1933 again pronounce the same idea.

[4a]) Experiments with mixtures of hydrogen on oxygen with the rare gases prove that there is very probably no isotope of neon of mass 23, and no isotope of argon of mass 41. A second criterion to distinguish between isotopes and hydrides of the same mass is given by the phenomenon of multiple charges. The presence of oxygen increases the appearance of multiply charged ions of the rare gases. Even with potentials of only 16—20 K V, doubly ionised *He*, quadruply ionised *Ne*, and quadruply on quintriply ionised *Ar*, are easily observed. Rare gas hydrides never exhibit these multiply charged states. The hydrogen isotopes give a means of studying the hydrides in another direction.

[5]) W. H. KEESOM, H. VAN DIJK, J. HAANTJES Proc. Amsterdam **36**. 248. 1933, see also the note [1]); in their publication, pag. 252.

[6]) While this paper was in the press Prof. KEESOM kindly supplied us with some 3 cm³ containing at least 10% $H^1 H^2$ molecules. We obtained now the parabola $\frac{m}{e} = 6$ corresponding to the $(H^2 H^2 H^2)^+$ ion with an exposure of less than one hour.

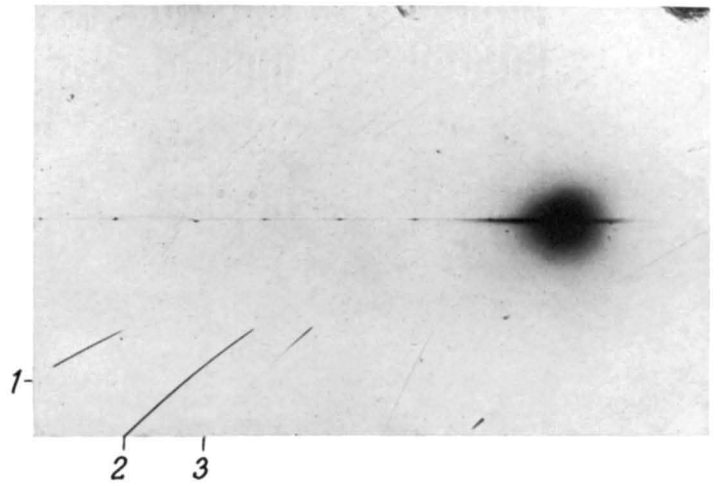

Fig. 1.

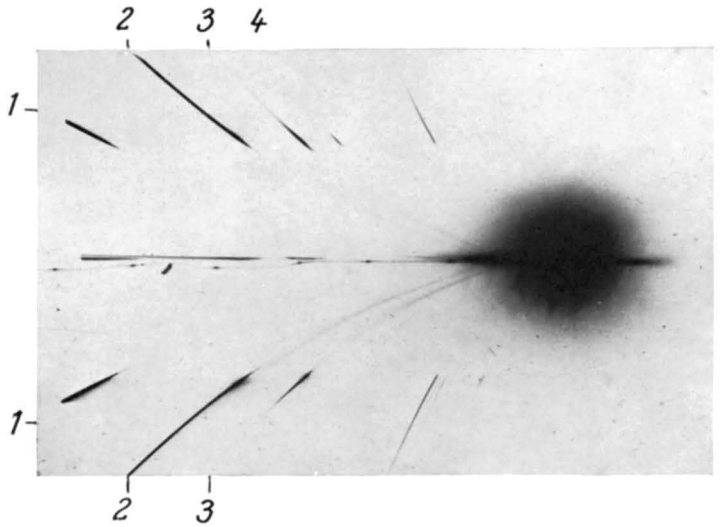

Fig. 2.

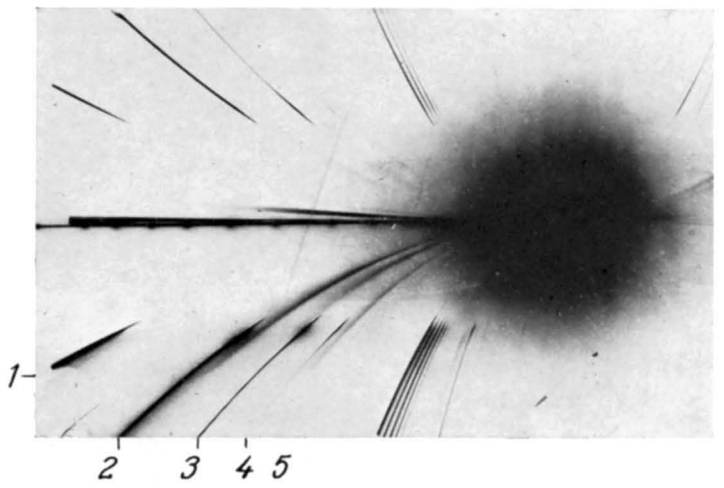

Fig. 3.

The normal triatomic hydrogen ion is produced directly by the process [7])

$$H_2^+ + H_2 \rightarrow H_3^+ + H$$

according to the balance of evidence.

If the molecule or ion contains a H atom we may obtain a triatomic ion with $\frac{m}{e} = 4$ [8])

$$H^1 H^{2+} + H_2^1 \rightarrow H_2^1 H^{2+} + H^1$$

$$H_2^{1+} + H^1 H^2 \rightarrow H_2^1 H^{2+} + H^1$$

For an ion with $\frac{m}{e} = 5$ we find the production given by

$$H^1 H^{2+} + H^1 H^2 \rightarrow H^1 H_2^{2+} + H^1$$

$$H_2^{2+} + H_2^1 \rightarrow H^1 H_2^2 + H^1$$

$$H_2^2 + H_2^{1+} \rightarrow H^1 H_2^2 + H^1$$

Hence it follows that high pressure and great current intensity must be favourable for the production of the different triatomic ions. The pressure in the discharge tube must be rather high, because the available tension is low. The current intensity could not be varied independently of the pressure: more intense current demands higher pressure. It therefore turned out that there was no advantage increasing the current intensity as much as possible. The relative abundance might then increase, but the smaller free path length at the same time increases the probability of destruction of the produced ion. The pressure between the fine slits is also increased by leak from the discharge tube. Hence the geometry of the apparatus determines an optimum for pressure and current intensity. [9]) It appeared to be of importance that the tube was held free from oxygen. The "hydrides" of hydrogen apparently are rather easily oxidized. The best way is to wash with hydrogen till the parabolas of the hydrocarbons of the unavoidable greasy vapours do not exhibit prolongations. (If there is no oxygen present, these only rarely indicate double charges). Further impurities appeared then no more confusing.

DESCRIPTION OF PLATE.

Fig. 1. Short exposition with normal hydrogen.

Fig. 2. At the top, hydrogen with admixture of heavy isotope.
At the bottom, ordinary hydrogen (electric field reversed).

Fig. 3. At the top, hydrogen with heavy isotope admixed.
At the bottom, the same with long exposure. (Voltage 17 K. V., current 3 m.A.). On the original the H_5 line is clearly seen. In the reproduction it is undoubtedly visible as a trace.

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7) H. D. SMYTH, Rev. of modern Physics **3**, 347. 1931.

8) K. T. BAINBRIDGE, Phys. Rev. **42**, 1. 1932.

9) BRASEFIELD, Phys. Rev. **31**, 52. 1928.