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the electron assumes under influence of the field determined by \bar{q} and \bar{p} .

§ 5. *Conclusions.* In the above considerations I have tried to show that it is possible to account for the partition of energy in the normal spectrum with the aid of differential equations, which admit of a continuous emission and absorption of energy, and that it is therefore not necessary for the explanation of the normal spectrum to have recourse to the supposition of quanta, either of energy or of "action". For this explanation it is necessary to draw up a system of mechanics, in which a relation of the form (6) takes the place of the equation of LIOUVILLE in "classical" mechanics. In order to determine this equation further knowledge of the function φ would be required, which function can be found by solution of the integral equation (5). I have however not succeeded in this solution.

If such an explanation with the aid of continuous equations is possible for the partition of energy in the spectrum, then this will also be the case for the variation of the specific heat with the temperature, which follows from this energy partition.

Chemistry. — "*Hexatriene 1, 3, 5.*" By Prof. P. VAN ROMBURGH.

(Communicated in the Meeting of February 22, 1913)

In previous communications, published in this Proceedings¹⁾, an account was given of the results of an investigation carried out jointly with Mr. VAN DORSSSEN and which had led to the preparation of the above hydrocarbon. Owing to the departure of Mr. VAN DORSSSEN the continuation of the study of hexatriene has experienced considerable delay. Since then, however, a fairly considerable quantity of this substance has been prepared and kept in sealed bottles. As hexatriene — as might be expected from its analogy with other unsaturated compounds (and what also proved to be the case) — exhibited a tendency towards polymerisation particularly on warming, I have submitted the contents of the bottles which had been kept for five years, to investigation.

On distillation fully 50% passed over below 80°: the residue in the flask was then distilled in vacuo. At $\pm 100^\circ$ about 30% passed over whilst in the flask was left behind a colourless, very viscous mass which dissolves in benzene. From this solution it is again precipitated by acetone or alcohol. If the residue is heated more strongly,

¹⁾ Nov. and Dec. 1905; June 1906.

there remains a colourless, transparent, gelatinous product which swells in contact with benzene, but does not dissolve therein.

The liquid boiling at about 100° in vacuo, when distilled at the ordinary pressure passes over at $\pm 215^{\circ}$ with formation, however, of products with a higher boiling point. After fractional distillation in vacuo the bulk was obtained as a perfectly colourless liquid which is more viscous than hexatriene (b.p. $99^{\circ}.5$ at 16 mm. pressure).

The elementary analysis (found: C 89.43, H 10.1; calculated C 89.91, H 10.09) and the vapour density determination (according to HOEMANN: found 5.5; calculated 5.5) led to the formula $C_{12}H_{16}$, so that the substance is to be considered as a dimer of hexatriene.

$$D_{4}^{25} = 0,880 \quad n_D^{25} = 1.51951$$

$$MR = 55.2 \quad \text{Calculated for } C_{12}H_{16} \left(\frac{1}{4} 53.54 \right)$$

The density is considerably higher than that of hexatriene (0.7498 at 13°) whereas the exaltation of the molecular refraction is much smaller. This is particularly striking when we compare the spec. exaltations.

$$\text{For hexatriene } E \Sigma_D = 3.125$$

$$\text{For the dimer } E \Sigma_D = 1.037$$

The dimer of hexatriene readily forms an additive compound with one mol. of bromine; on further addition much hydrogen bromide is eliminated. It is rapidly oxidised by a solution of potassium permanganate. The investigation thereof is being continued.

The method by which hexatriene was formerly obtained (interaction of formic acid on s. divinylglycol) did not exclude the possibility that it might be contaminated with hydrogenated derivatives thereof and hence it was thought desirable to try other means and get it in a pure condition by regeneration from crystalline derivatives. Mr. MULLER who for a considerable time has been engaged on the study of hexatriene has succeeded in regenerating the hydrocarbon from the beautifully crystallised dibromo additive compound. By treating hexatriene with sulphur dioxide he has also obtained a solid product, the investigation of which is not yet concluded and from which the hydrocarbon may be prepared also.

It was further to be expected that hexatriene would also be formed by dehydration of the hexadiene 1.5-ol 4, which alcohol might be obtained by reduction of the divinylethylene oxide recently descri-

¹⁾ Here it has been assumed that with elimination of two double bonds, a ring has been formed, as suggested by the high density.

bed by Mr. LE HEUX¹⁾. The yield of the alcohol from the oxide, already so difficult to prepare, was, however, so small that the application of this method was out of the question.

Jointly with Mr. VAN DORSSSEN, I endeavoured some time ago to prepare this alcohol according to the method applied by FERD. TIEMANN and R. SCHMIDT²⁾ in the preparation of homolinalool where they allowed a mixture of allyl iodide and methylheptenone to act on granulated zinc. With acraldehyde and allyl iodide we did not get a successful reaction. Nor did we succeed in obtaining the desired alcohol by the interaction of these substances in ethereal solution on "activated" zinc (GILLSTONE and TRIBE), whilst in an experiment with 70 grams of zinc filings, 60 grams of allyl iodide and 60 grams of acraldehyde only a slight action took place, so that we refrained from further experiments.

Mr. LE HEUX has tried, in vain however, to obtain the desired alcohol by means of allyl bromide, acraldehyde and magnesium.

The favourable result obtained by Dr. C. J. ENKLAAR³⁾ when applying the method of FOURNIER⁴⁾ to crotonaldehyde for the preparation of the heptadiene 2.6-ol 4, induced Mr. LE HEUX to allow (according to FOURNIER's directions) allyl bromide, zinc turnings and absolute ether to act on acraldehyde with the object of obtaining the alcohol in larger quantities. With a yield of 30% of the theoretical quantity, the hexadiene 1.5-ol 4 was now obtained as a liquid boiling at 132°.2 — 132°.4 under 769 m.m. pressure. The elementary analysis and the vapour density determination confirmed the formula C₆H₁₀O.

$$D_4^{10.5} = 0.8698$$

$$n_D^{10.5} = 1.45231$$

$$MR = 30.44$$

$$\text{calculated } 30.498$$

The odour of the alcohol reminds of that of allyl alcohol but it does not produce the irritating after effect, however.

With acetic anhydride and a drop of sulphuric acid the acetate is formed as a liquid boiling at 151°.2 — 152°.7.

Phosphorous tribromide yields the bromide (bp. 59°—63° at 35 mm. pressure) which very readily absorbs 1 mol. of bromine; a further addition of bromine acts but very slowly without, however, yielding hydrogen bromide.

From this alcohol Mr. MULLER has obtained a hydrocarbon, by the

¹⁾ Proc. April 1912.

²⁾ B. 29, 691 (1896).

³⁾ Chem. Weekbl. 10, 60 (1912).

⁴⁾ Bull. Soc. Ch [3] 11, 124 (1894).

action of potassium hydrogen sulphate as well as of phthalic anhydride, which, judging from provisional experiments consists of hexatriene.

In consequence of the fact noticed by Dr. C. J. ENKLAAR (*loc. cit.*) that the homologue of hexatriene which he prepared can be obtained in a crystalline condition by strong cooling, Mr. MULLER has cooled a freshly prepared and carefully fractioned specimen of hexatriene in a mixture of solid carbon dioxide and alcohol and obtained it also in the crystalline form ¹⁾, so that this fact may be utilised for the purification of this hydrocarbon.

Finally it may be mentioned here that Mr. LE HEUX, by reduction of the chloroacetone of *s.* divinylglycol with a copper-zinc couple in ethereal solution with addition of hydrochloric acid, obtained a liquid boiling at 77°—81° which on strong cooling became crystalline and consists very probably of hexatriene 1, 3, 5. At any rate it yields with bromine a dibromide identical with the dibromide from the said hydrocarbon.

Utrecht.

Org. Chem. Lab. Univ.

Physics. — “*On Einstein's theory of the stationary gravitation field.*”

By Prof. P. EHRENFEST. (Communicated by Prof. H. A. LORENTZ).

(Communicated in the meeting of Febr. 22, 1913).

§ 1. Let a “laboratory” *L* with the observers in it have some accelerated motion with regard to a system of coordinates x, y, z , which is not accelerated. Let it e.g. move parallel to the z -axis with some positive acceleration or other. Then the observers will find that all the inert masses which are at rest with regard to the laboratory, exert a pressure on the bodies which are in contact with their bottom side. There are two ways for these observers to explain this pressure: *a.* “Our laboratory has an acceleration upwards, hence all inert masses press on the bodies under them.” *b.* “Our laboratory is at rest. A field of force acts in it, which pulls the masses down.”

Observations on the course of the rays of light seem to make it possible to decide experimentally between the suppositions *a* and *b*: with regard to the system of coordinates x, y, z the light travels rectilinearly. Hence with regard to an accelerated laboratory *curvilinearly*. By means of this curvilinear propagation of the rays of light the observers might therefore ascertain that their laboratory has an accelerated motion.

¹⁾ Preparations which have been kept for some time and then contain polymerides do not solidify even at this low temperature.