Then the energy balance of the transmutation of the neutron into a proton and an electron will be written as follows:

$$n + h\nu = n + e^{+} + e^{-} + E^{1} = p + e + E^{1} \quad (10)$$

where

$$E^{1} = h\nu - h\nu_0 = h\nu - 2mc^2 \quad (11)$$

The energy E^1 can be manifested in the form of the kinetic energy of the proton and the electron, or in the form of a quantum of radiation, the energy of which is

$$h\nu^{1} = h\nu - h\nu_0 = h\nu - 1{\cdot}02 \times 10^6 \text{ e.v.} \quad (12)$$

(if the kinetic energies of the proton and the electron vanish).

The energy balance in the transmutation of a proton into a neutron and a positron is:

$$p + h\nu = p + e^{+} + e^{-} + E^{1} = n + e^{+} + E^{1} + h\nu_0 \quad (13)$$

where E^1 is also given by equation (11).

It therefore follows that if the scattering of γ-rays is accompanied by the transmutation of a neutron into a proton and an electron, the maximum hardness of the scattered rays is determined by equation (11). If the scattering of γ-rays is accompanied by the transmutation of a proton into a neutron and a positron, then a scattered component of $1{\cdot}02 \times 10^6$ e.v. appears.[5]

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[1] D. Iwanenko, *C.R. Acad. Sci. U.R.S.S.*

[2] F. Joliot, *C.R. Acad. Sci.*, **197**, 1623; 1933. J. Thibaud, *C.R. Acad. Sci.*, **197**, 1629; 1933.

[3] cf. M. N. Saha and D. S. Kothari, NATURE, **132**, 747, Nov. 11, 1933. **133**, 99, Jan. 20, 1934.

[4] J. Chadwick, *Proc. Roy. Soc.*, A, **142**, 1; 1933.

[5] L. H. Gray and G. T. P. Tarrant, *Proc. Roy. Soc.*, A, **143**, 681, 766; 1934.

Absorption Spectrum of Mercuric Sulphide

FROM a recent note by Iredale and Gibson[1], it seems that the authors have not been able to isolate the absorption spectrum of HgS, observed by me[2], from that of sulphur vapour in the range of temperatures they have worked, and they are of opinion that the absorption continua ascribed by me to HgS probably belong to sulphur vapour, because these lie in the neighbourhood of the absorption maxima of sulphur vapour at 4000 A. and 2670 A. when raised to the temperature of 400° C.

I have shown[3] how the HgS continua could be distinguished from those of sulphur. The HgS absorption spectrum was investigated chiefly at 500° C. and above. At this temperature there is always some decomposition of HgS, but the decomposed sulphur is in the S_2 state, not the S_8 state, so that it is impossible for the S_8 bands to manifest themselves at this temperature. The observed continuous absorption at 4450 A. could thus be only that of HgS. It would not matter if the concentration of the decomposed product (sulphur) be greater than that of the original compound (HgS), because there is still sufficient vapour of the compound to give good absorption. Now, the S_2 bands present at 500° C. or at a slightly higher temperature lie in the region 3500–3200 A., as seen from a separate experimental observation by me. This region was almost completely superposed by the continuous absorption by the sulphide. The second absorption at 3100 A. could only be due to HgS alone, as at this temperature no absorption due to sulphur is obtained in this region.

The next point refers to the constitution of HgS. I have not assumed an electronic structure like Hg $({}^1S_0) - S\,({}^3P)$ for HgS, as Iredale and Gibson seem to believe. My conclusions were based on the assumption that HgS is ionic, having a structure $\text{Hg}^{++}\,({}^1S_0) - S^{--}({}^1S_0)$ giving a ${}^1\Sigma$ state. Under the influence of light, both the electrons in S^{--} go to Hg^{++} simultaneously, giving two normal atoms, as I have already explained.

My results and views on the subject receive further support from the fact that the deduced value of the heat of dissociation of sulphur agrees very closely with some other values determined by other experimental methods.

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Aug. 1.

[1] NATURE, **133**, 985, June 30, 1934.

[2] Sen-Gupta, *Proc. Roy. Soc.*, A, **143**, 438; 1934.

[3] loc. cit.

Absorption Spectrum of Nitrous Oxide and Energy of Dissociation of Nitrogen

OWING to the importance of the determination of the energy of dissociation of nitrogen, it seems of interest to mention the value of D_{N_2} obtained by the study of the absorption spectrum of nitrous oxide (N_2O). This method, although an indirect one, gave a value of $D_{N_2} = 6{\cdot}9 \pm 0{\cdot}2$ volts, which is in fairly good agreement with the latest value of Herzberg and Sponer[1], $D_{N_2} = 7{\cdot}34$ volts.

We have measured the absorption spectrum of nitrous oxide at various temperatures and pressures. The limit of the continuous absorption is shifted towards the long wave-length with rising temperatures. From measurements made on photomicrometric curves for a wide range of temperatures, the limit of absorption extrapolated for $T_{\text{abs}} = 0$ was found to be 2140 ± 130 A.; this corresponds to the energy $D_{N_2O} = 132{,}000 \pm 8{,}000$ calories. We studied in Prof. Victor Henri's laboratory in Liege the photochemical decomposition of nitrous oxide by the radiations of a powerful cadmium spark filtered through layers of acetic acid of various concentrations. The absorption spectrum taken after the photochemical reaction showed the appearance of increasing amounts of nitric oxide; the mechanism of photochemical reaction can thus be explained as:

$$N_2O = NO + N.$$

Nitrous oxide being diamagnetic, according to Herzberg[2] its fundamental electronic state can only be a singlet (${}^1\Sigma$). Such a state can only result from the adiabatic combination of individuals (NO and N) of equal multiplicity. The normal state of NO is ${}^2\Pi$; the normal state of the nitrogen atom is ${}^4S$; N_2O cannot be formed by the adiabatic union of a normal NO molecule with a normal N atom. The next state of N is a metastable (${}^2D$), 2·27 volts higher than (${}^4S$). The photochemical decomposition of N_2O can thus be explained as:

$$N_2O\,({}^1\Sigma) = NO\,({}^2\Pi) + N\,({}^2D) - 132{,}000 \text{ calories.}$$

This liberation of metastable atoms of nitrogen accounts for the shift of the absorption limit towards the long wave-lengths with rising temperatures (transfer of energy to N_2O molecules not yet decomposed). Accepting this mechanism of decomposition, a series of simple thermochemical equations gives for the energy of decomposition of the normal nitrogen molecule into normal nitrogen atoms :

$$(D)_{N_2}(^1\Sigma)\rightarrow_{N_2}(^4S) = 6\cdot9 \pm 0\cdot2 \text{ volts} = 158{,}000 \pm 8{,}000 \text{ calories.}$$

This value is much lower than the 8·7 volts deduced by Dutta[3] ; however, it is in good agreement with the latest results of Lozier[4] who gave 7·42 volts, of Kaplan[5], 7·42 volts, of Maier and Sponer[6], 6·7 to 7·2 volts and with the quite recent and safe value of Herzberg and Sponer[1], 7·34 volts.

It is hoped that the study of decomposition of nitrous oxide by electron impact, being made, combined with a careful study of the energy states of the decomposition products, will give a more accurate value of D_{N_2}.

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[1] Herzberg and Sponer, *Z. Phys.*, **26**, 1 ; 1934.
[2] Herzberg, *Z. phys. Chem.*, **17**, 68 ; 1932. *Ann. Phys.*, **5**, 677; 1934.
[3] Dutta, *Proc. Roy. Soc.*, A, **138**, 84 ; 1932.
[4] Lozier, *Phys. Rev.*, **45**, 841 ; 1934.
[5] Kaplan, *Phys. Rev.*, **45**, 757 ; 1934.
[6] Maier and Sponer, *Z. Phys.*, **89**, 431 ; 1934.

Photosynthesis of Amino Acids *in Vitro*

RECENTLY we have been successful in synthesising amino acids by exposing solutions of glycol or glucose and nitrates to sunlight for six to eight hours in presence of titania, used as a photocatalyst. The amino acids formed can be estimated colorimetrically by the valuable 'ninhydrin' (triketo-hydrindene hydrate : $C_6H_4{<}\genfrac{}{}{0pt}{}{CO}{CO}{>}C(OH)_2$) test. The following results were obtained by exposing to sunlight 100 c.c. of $N/2$ nitrate solutions and 5 gm. of glucose and 1 gm. of TiO_2 in open 250 c.c. pyrex glass beakers :

Time of exposure.	Amount of amino acids formed with different nitrates. $N/2$ NH_4NO_3	$N/2$ $NaNO_3$	$N/2$ KNO_3
2 hours	nil	nil	0·000120 N
4 hours	0·000055 N	0·000274 N	0·00040 N
6 hours	0·00125 N	0·00040 N	0·00084 N
8 hours	0·001096 N	0·00024 N	0·00110 N
10 hours	0·00053 N	0·00020 N	0·00034 N
12 hours	nil	0·000185 N	0·00027 N
Dark	nil	nil	nil

The foregoing results show that the amount of amino acids photosynthesised is a maximum with ammonium nitrate and less with sodium nitrate. Moreover, the amino acid photosynthesised reaches a maximum value with increase of exposure and then falls off as the exposure is continued. After 15–20 hours exposure, very little amino acid is detected. The disappearance of the photosynthesised amino acids is due to their oxidation. When $N/2$ ammonium hydroxide or ammonium salt is substituted for the nitrate, no amino acid is photosynthesised, neither is there any amino acid formation in the dark. When the concentration of glucose is increased, the yield of amino acid is increased.

Tartaric acid, glycol, glycerol, arabinose, fructose, mannose, galactose, etc., can also be used instead of glucose in photosynthesising the amino acids, which are also formed when ammonium lactate is exposed to sunlight with TiO_2. Our experiments show that glycine is mainly formed with glycol and potassium nitrate, and arginine with glucose and potassium nitrate. Small amounts of amino acids are also synthesised by exposing solutions of glucose and nitrates with ammonium uranium carbonate used as a photocatalyst instead of TiO_2.

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The Philosophy of Sir James Jeans

THE excellent article by "H. D." with the above title[1] seems to me to require a little historical emendation. To regard science as a process of describing and co-ordinating sensations, and matter, space, time and so on as mental concepts introduced to make this co-ordination easier, is not characteristic of the new physics unless we are prepared to date the latter from the eighties of last century. Analyses on these lines were given quite explicitly by Mach then, and were further developed by Karl Pearson in "The Grammar of Science". Full acknowledgment to Mach was made by Einstein in his earlier papers, but both these pioneers seem to have got overlooked in later developments.

Nor am I satisfied that the new physics shows any more understanding of the nature of its methods than the old. One realism is disposed of merely to be replaced by a different realism ; the relation to observation of parallel displacements and ψ-functions is as hazy as that of anything in the old physics. The problem of inference is still shirked ; the a priori certainty of Euclidean mensuration and Newtonian dynamics has gone, but in its place we have the a priori certainty of the principle of general relativity. The new wine is there, and so are suitable bottles, though the latter are not as new as they were ; but the old bottles are still being used.

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[1] NATURE, **134**, 337, Sept. 8, 1934.

I GLADLY join in Dr. Jeffreys's tribute to Mach and Karl Pearson, but I would suggest that these thinkers do not constitute 'science'. I do not think it can be gainsaid that the great majority of the most prominent scientific workers (Lord Kelvin, of course, springs to mind, and I think he is typical) did not regard science as Dr. Jeffreys defines it. Indeed, if the views of isolated individuals are to be accepted as 'science', I am not sure that we ought not to go back much further than the eighties of last century—at least to Newton, who regarded the absoluteness of motion as having an experimental and not an a priori foundation.

Space obviously precludes a proper discussion of Dr. Jeffreys's second paragraph, which I do not altogether understand. In speaking of "the new physics", is he still thinking only of the most far-seeing of new physicists, or has he tacitly changed to the general body ? If the former, I certainly dissent ; if the latter, it is a question of the degree of generality. My own view is that while, of course, "the old bottles are still being used", their use is far less general than it was thirty years ago, and the present generation of physicists is relatively so enlightened as to justify the statements of my article.

H. D.