the mathematical theory of the motion developed in this way was given by Rayleigh[1] in 1917, in explanation of the model cyclones devised by Aitken[2]; the mathematical theory was extended by Brunt[3] in 1921 to apply to motion on a rotating earth.

The inner regions generally are found not to be examples of 'solid spin', at least in the lowest 2 km. of the atmosphere, but rather, in certain parts, regions of specially marked convergence. In brief, it is found that—below the 2 km. level—convergence towards the centre goes on, roughly with complete conservation of moment of momentum up to a certain distance (which in different cases varies from 300 km. to 500 km.) from the centre, and then—in place of conservation—there is, instead, as the air enters the inner region, a gradual fall of speed with closer approach to the centre.

The total inward flux of kinetic energy across the periphery of the inner region is so considerable—speeds at this periphery being commonly of the order of 40 m.p.h.—that a question naturally arises as to what work is being done to account for the loss of kinetic energy by the air in the course of its closer approach to the centre. The obvious explanation is that here is the work required in the later stages of the depression's life to raise bodily the large central core of troposphere which, by reason of continued ascent, has become colder, level for level, than its environment. Calculation in a typical case indicates that about half the probable inward flux of kinetic energy below the 2 km. level would suffice to keep the core above this level moving upward until it had become on the average about 7° C. colder, level for level, than surrounding regions. This result, therefore, explains the manner in which depressions can continue in being until they acquire temperature characteristics which have hitherto seemed paradoxical, more especially in regard to any theory of origin in which convection may have played a part.

In one exceptional case—a vigorous and still developing system with a long course still to run—the feature characteristic of the inner regions of the other depressions was not developed, at least at the time when the depression crossed the British Isles. In this depression by contrast, a high wind speed was found up to relatively near the centre.

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[1] *Proc. Roy. Soc., Lond.*, A, **93**, 148 (1917).
[2] *Trans. Roy. Soc., Edin.*, **40** (1900–01); *Proc. Roy. Soc., Edin.*, **36** (1915); and *Proc. Roy. Soc., Lond.*, **94** (1917–18).
[3] *Proc. Roy. Soc., Lond.*, A, **99**, 397 (1921).

Transmission of High-Voltage Impulses at Controllable Speed

SIR J. J. THOMSON[1] first observed that if a difference of potential was applied to the ends of a long discharge tube (by an induction coil) the luminosity traversed the tube with a finite velocity. When either a positive or negative impulsive potential is suddenly applied to one end of a discharge tube while the other end is maintained at ground potential, one of us[2] found that the luminosity traversed the tube from the high-voltage electrode to ground. Immediately following this, a luminosity frequently traversed the tube from the ground back to the high-voltage electrode. A similar type of propagation of luminosity has been observed in a million volt spark between point and plane by Allibone and Schonland[3] and by Schonland and others[4] for certain types of lightning flashes. In order to obtain more information about the initial breakdown in gases, we have undertaken an investigation of the propagation of potential in long discharge tubes when impulsive voltages are applied to one end of the tube while the other end is earthed.

By means of a high-speed cathode ray oscillograph, it was found that in the case of both positive and negative applied impulses, a definite potential wave traversed the tube from the high-voltage electrode to the earthed electrode, immediately followed by a much faster return wave from ground back to the high-voltage electrode. In the case of the initial impulse, the wave velocity, wave form, voltage attenuation and energy carried in the wave front were measured and found to vary with both pressure and applied potential. A few values for the speed of the initial impulse in a 5 mm. glass tube containing air are shown in the accompanying table.

Applied Voltage (kv.)	Pressure (mm. Hg.)	Speed of Impulse (cm./sec.)
+127	0·08	9×10^8
+127	0·24	43×10^8
−125	0·03	15×10^8
+171	0·17	27×10^8
+ 74	0·017	$5{\cdot}4 \times 10^8$
+ 74	0·24	14×10^8

For the greater applied potentials the voltage wave showed no observable distortion or attenuation, at least for lengths of tube less than 10 metres. However, at 74 kv. and the higher pressure (0·24 mm.), the voltage wave was very much flattened. For the 170 kv. and 74 kv. applied impulses with 0·025 mm. pressure in the tube, the maximum current during the initial wave was 429 amp. and 146 amp. respectively. In addition to the information the above results give as to the nature of the initial breakdown in gases, they show that a discharge tube may be used as a transmission line in which the velocity of propagation of the voltage wave is easily controllable over quite wide ranges. This type of transmission line should be of use in many problems[5] where it is necessary to transmit high-voltage impulses from point to point at predetermined velocities less than that of light.

The detailed results of this experiment will be submitted for publication elsewhere. We wish gratefully to acknowledge a grant from the American Philosophical Society, which has made this work possible.

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June 20.

[1] "Recent Researches", 115 (1893).
[2] Beams, *Phys. Rev.*, **36**, 997 (1930).
[3] Allibone and Schonland, NATURE, **134**, 736 (1934).
[4] Schonland, Malan and Collins, *Proc. Roy. Soc.*, A, **152**, 595 (1935).
[5] Beams and Snoddy, *Phys. Rev.*, **44**, 784 (1933).

Narrow Continuous Band of Potassium in the Extreme Red

ALTHOUGH the absorption bands which appeared, as reported by Kuhn[1] and Datta[2], near the principal series lines of potassium at high vapour pressures were interpreted on the assumption of polarisation of the molecule, the bands which may have appeared near the resonance lines λλ7699, 7665 were not observed.

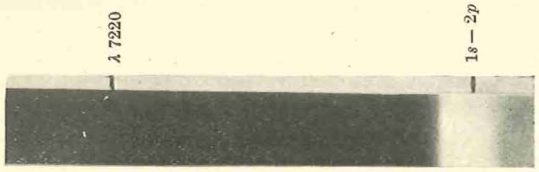

FIG. 1.

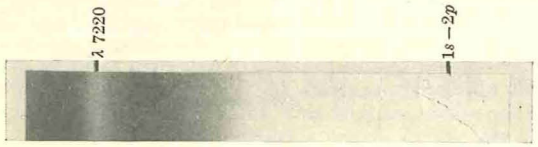

FIG. 2.

With the view of searching for these bands, the extreme red absorption spectrum of potassium vapour was investigated. By heating the potassium metal in a steel tube filled with hydrogen to a pressure of about 10 cm. mercury, spectral photographs of the potassium vapour were taken at the first order region of the 1·5 m. concave grating. When the continuous light from a carbon arc passed through the vapour, keeping the temperature sufficiently high, a remarkable broadening of the resonance lines, as shown in Fig. 1, was observed. At higher temperatures a narrow continuous band appeared at about λ7220 (Fig. 2), while Fig. 3 shows its photometer curve. In the absence of hydrogen this band was also observed, but with difficulty.

FIG. 3.

Wurm[3] reported a narrow band of sodium appearing on the shorter wave-length side of the *D*-lines, explaining it by assuming polarization of the molecule. Hamada[4] observed the fluctuation of a continuous band in the same region, considering its origin as the sodium quasi-molecule. The potassium λ7220 band may be interpreted in the same manner.

Though the longer wave-length side of the potassium resonance lines was also photographed, the absorption of the $A^1\Sigma \rightarrow B^1\Sigma$ band was so strong that any narrow continuous band was difficult to observe.

T. OKUDA.

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Osaka Imperial University,
Japan. May 12.

[1] H. Kuhn, *Z. Phys.*, **76**, 782 (1932).
[2] S. Datta and B. H. Chakrovarty, *Ind. J. Phys.*, **7**, 273 (1932).
[3] W. Wurm, *Z. Phys.*, **79**, 736 (1932).
[4] H. Hamada, *Phil. Mag.*, **15**, 574 (1933).

Liquids of High Refractive Index

IN a previous letter to NATURE[1] under this title, we gave values for the refractive index of phenyldi-iodoarsine as measured by us. Our attention has now been directed to the fact that the properties of this compound had already been accurately measured and published in a valuable paper on "The Optical Properties of Arsenic" by Gryszkiewitz-Trochimowski and Sikorski[2] which had appeared six years previously. We had unfortunately overlooked this paper owing to the fact that in none of the abstracts or collective indexes which we consulted as a guide to the relevant literature was there any mention of the above compound in connexion with these authors. The figures for phenyldi-iodoarsine given by the Polish workers ($n_D^{14\cdot5}$ 1·8527 ; $d_4^{14\cdot5}$ 2·6264) are higher than those we communicated, but agree closely with those we have recently obtained with the purer samples now commercially available.

We take this opportunity to add a warning note. Though we occasionally use phenyldi-iodoarsine when refractometer readings of high index are required, the action of this liquid on the soft glass hemisphere of the instrument is distinctly deleterious. The chief usefulness of this remarkable compound will thus probably be as an immersion medium.

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[1] NATURE, **133**, 66 (1934).
[2] Gryszkiewitz-Trochimowski and Sikorski, *Roczniki Chemji*, **8**, 405 (1928).

Structure of Bromine III

IN a previous letter[1] it was reported that the structure of Br III was detected, the intervals of the fundamental term $5s\ ^4P$ being 2589 cm.$^{-1}$ and 2253 cm.$^{-1}$. A further comprehensive investigation, carried out particularly to distinguish between the lines of Br II and Br III, has led to a considerable extension of the scheme, which consists of doublets and quartets of the 4*p*, 5*p*, 5*s*, 4*d* and 5*d* configurations. On account of the large intervals of the 4*d* and 5*d* configurations, it is difficult to assign the *L*-values to these terms. Assuming an arbitrary value of 300,000 cm.$^{-1}$ for $4p\ ^4S_{1\frac{1}{2}}$, some of the chief term values are :

$5p\ ^4D_{\frac{1}{2}}$	126823	$5p\ ^4P_{1\frac{1}{2}}$	121875
$5p\ ^4D_{1\frac{1}{2}}$	126165	$5p\ ^4P_{2\frac{1}{2}}$	119751
$5p\ ^4D_{2\frac{1}{2}}$	124095	$5s\ ^4P_{\frac{1}{2}}$	154588
$5p\ ^4P_{\frac{1}{2}}$	123335		

The intervals of $4p\ ^2D$ and ^2P are found to be 1259 cm.$^{-1}$. and 1665 cm.$^{-1}$ respectively. About 200 lines of Br III have been classified altogether.

The complete analysis is being communicated to the Royal Society of London.

K. R. RAO.

Andhra University,
Waltair.
May 27.

[1] NATURE, **135**, 309 (1935).

Preparation of Lithium Alum

DURING some work on the mass susceptibility of the alums, a successful attempt was made to prepare lithium alum, despite the fact that its existence and even the probability of its existence has been repeatedly denied.

Molecular proportions of the monohydrate of lithium sulphate and the octadecahydrate of aluminium sulphate were dissolved in the minimum quantity of cold water. The solution was concentrated considerably by evaporation on a sand bath and cooled in a freezing mixture of ice and salt with vigorous stirring, when it crystallized suddenly and deposited a mass of very soft small crystals, which were filtered and dried at the pump and afterwards on porous plates. The mother liquor after a further slight concentration deposited small hard transparent crystals on keeping in the freezing mixture.

Both crops of crystal contain 49·00 per cent of water ($Li_2SO_4Al_2(SO_4)_3.24H_2O$ requires 48·93 per cent water). The crystals are isotropic, a combination of cube and octahedron. On keeping at ordinary temperature, or on warming a few degrees, they decompose and the salts dissolve in the liberated water. They are exceedingly soluble in water; they lose the whole of the water at 200° C. and swell to a bulky friable mass. The mass susceptibility is $-0{\cdot}541 \times 10^{-6}$ and molecular susceptibility -479×10^{-6}. The properties of the alum are under investigation.

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Points from Foregoing Letters

DR. A. S. RUSSELL describes work which suggests that metals of the class which forms compounds with metals of the copper, iron, cobalt and nickel class may be arranged in a list analogous to the electrochemical series. Any metal in this list can displace from intermetallic combination one lower in the list.

The formation of long carbon dendrites has been observed by K. D. Luke and Drs. W. M. Madgin and H. L. Riley in the cathodic reduction of colloidal solutions of graphitic oxide. Colloidal particles of graphitic oxide are negatively charged, and the reduction occurs in spite of the strong repulsive forces which must exist in the neighbourhood of the cathode.

The large majority of the negative ions formed during electric discharge in mercury vapour, hydrogen, nitrogen and carbon dioxide, Dr. F. L. Arnot finds, do not arise by the attachment of one electron to a neutral atom, but by the attachment of two electrons to a positively charged ion. The author calculates the probability of such conversion from positive into negative ions, for the gases mentioned above, at the surface of a negatively charged nickel electrode.

From the energy of the neutrons selectively captured by rhodium, Drs. P. Preiswerk and H. von Halban, jun., deduce the distance, breadth and form of the nuclear levels in that element. The data required were obtained by determining the absorption coefficient for each additional layer of rhodium.

Light falling upon a cuprite crystal in contact with two electrodes through which an alternating current is passing, produces an additional direct voltage. Dr. G. Groetzinger and J. Lichtschein submit curves showing how the resulting direct voltage varies with the alternating current, and its relation to the crystal photo-electric effect. They consider that this additional current is connected with events taking place in the interior of the crystal.

Experiments on mice carried out by H. Burrows indicate that progesterone, a substance related to the male sex-hormone testosterone, can protect the genital organs of the non-castrated animals from the injurious effects of large doses of the female sex-hormone, œstrone.

An increased excretion of the yellow pigments, flavins, in the urine, after eating cooked ox-liver, is reported by A. Emmerie.

From the rate of sedimentation and the movement in an electric field (electrophoresis) of the protein particles from horse serum carrying an anti-body, Prof. M. Heidelberger, Kai O. Pedersen and Arne Tiselius conclude that the particles are of uniform size and possibly a definite chemical compound. The sedimentation constant is $17{\cdot}2 \times 10^{-13}$, and the anti-body is apparently formed from a heavier minor component of the protein. The rabbit anti-body against crystalline egg-albumin, on the other hand, is produced from the principal globulin component.

Two unusual modifications of eye colour in the fruit fly, under X-ray irradiation, are reported by Dr. E. V. Enzmann and C. P. Haskins. In one case the change was from white to red, involving apparently a reverse genovariation; in the second case mutations in a culture of eosin *Drosophila* produced eye colour considerably darker than eosin, showing that wild-type condition is not necessarily the end-point of change from light to darker shades.

In the centre of a 'depression', in the later stages of its existence, the air at a height of 4–9 km., though colder and therefore heavier than surrounding layers, is nevertheless ascending. The energy needed to lift it, Dr. A. H. R. Goldie suggests, is provided by the winds, which give up part of their energy and slow down as they converge spirally towards the centre of the depression.

The propagation of voltage impulses in long discharge tubes has been investigated by Dr. L. B. Snoddy, Prof. J. W. Beams, W. T. Ham, jun., and H. Trotter, jun. The tube was found to be an excellent transmission line for high-voltage impulses. The velocity of propagation was easily controllable over quite wide ranges of the order of 10^8–10^9 cm. per sec.

A broadening of the resonance lines in the extreme red of the absorption spectrum of potassium vapour in the presence of hydrogen gas is described by T. Okuda, who considers it due to the polarization of the molecules.

ERRATUM. Dr. C. H. Douglas Clark, referring to the paragraph in this column (July 18) on his letter "Optical Polarization Ellipsoids of the Hydrogen Halide Gases", states that it is the polarizability along the long axis which is equal to that of the corresponding negative ion.

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"To the solid ground
Of nature trusts the Mind that builds for aye."—WORDSWORTH.

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