Large questions now present themselves as to transformations which a distribution of turbulent motion would experience in an infinite liquid left to itself with any distribution given to it initially. If the initial distribution be homogeneous through all large volumes of space, except a certain large finite space, S, through which there is initially either no motion or turbulent motion, homogeneous or not, but not homogeneous with the motion through the surrounding space, will the fluid which at any time is within S acquire more and more nearly as time advances the same homogeneous distribution of motion as that of the surrounding space, till ultimately the motion is homogeneous throughout? Probably, I think I may say certainly, yes—at all events for a large class of cases.

But can it be that this equalization comes to pass through smaller and smaller spaces as time advances? In other words, will any given distribution, homogeneous on a large enough scale, become more and more *fine-grained* as time advances? Probably *yes* for some initial distributions; probably *no* for others. Probably *yes*, for vortex-motion given continuously through all of one large portion of the fluid while all the rest is irrotational. Probably *no* for the initial motion given in the shape of equal and similar Helmholtz rings, of proportions suitable for stability, and each of overall diameter considerably smaller than the average distance from nearest neighbour. Probably also *no*, though the rings be of very different volumes and vorticities. But probably *yes* if the diameters of the rings or of many of them, be not small in comparison with distances from neighbours, or if the individual rings, each an endless slender filament, be entangled or nearly entangled among one another.

Again a question: If the initial distribution be *homogeneous and æolotropic*, will it become more and more isotropic as time advances, and *ultimately quite isotropic?* Probably *yes* for any random initial distribution, whether of continuous rotationally-moving fluid or of separate finite vortex-rings. Possibly *no* for some symmetrical initial distribution of vortex-rings, conceivably stable; though it does not seem probable that there is any such stability.

If the initial distribution be homogeneous and isotropic (and therefore utterly *random* in respect to direction) will it remain so? Certainly *yes*.

We shall now suppose the initial motion to consist of a laminar motion $[f(y), 0, 0]$ superimposed on a homogeneous and isotropic distribution $(\mathfrak{u}_0, v_0, w_0)$; so that we have—

$$\text{when } t = 0, \; u = f(y) + \mathfrak{u}_0, \; v = v_0, \; w = w_0;$$

and we shall endeavour to find such a function, $f(y, t)$, that at any time, t, the velocity-components shall be—

$$f(y, t) + \mathfrak{u}, \; v, \; w,$$

where $\mathfrak{u}$, v, w are quantities of each of which every large enough average is zero.

With this assumption the equations of motion yield the following—

$$\frac{df(y, t)}{dt} = - xzav \frac{d(\mathfrak{u}v)}{dy}.$$

It is to be remarked that this result involves no isotropy, no homogeneousness in respect to y; and only homogeneousness of *régime* with respect to y and z, with no translational motion.

The translational component of the motion is wholly represented by $f(y, t)$, and, so far as our establishment of the above equation is concerned, may be of any magnitude, great or small relatively to velocity-components of the turbulent motion. It is a fundamental formula in the theory of the turbulent motion of water between two planes; and I had found it in endeavouring to treat mathematically my brother Prof. James Thomson's theory of the "Flow of Water in Uniform *Régime* in Rivers and other Open Channels" (Proceedings of the Royal Society, August 15, 1878). In endeavouring to advance a step towards the law of distribution of the laminar motion at different depths, I was surprised to discover the law of propagation as of distortional waves in an elastic solid, which constitutes the conclusion of my present communication—

$$\frac{d}{dt} \, xzav \, (\mathfrak{u}v = - \tfrac{2}{9} R^2 \frac{df(y, t)}{dy}.$$

Eliminating the first member from this equation, by the former, we find—

$$\frac{d^2 f}{dt^2} = \tfrac{2}{9} R^2 \frac{d^2 f}{dt^2}.$$

Thus we have the very remarkable result that laminar disturbance is propagated according to the well-known mode of waves of distortion in a homogeneous elastic solid; and that the velocity of propagation is $\frac{\sqrt{2}}{3}$ R, or about 47 of the average velocity of the turbulent motion of the fluid. This might seem to go far towards giving probability to the vortex-theory of the luminiferous ether.

But a difficulty remains unsolved: a possible rearrangement of vortices within each wave, giving rise to dissipation of the wave-energy.

The mathematical investigation appears in full in the October number of the *Philosophical Magazine*, with some slight farther considerations regarding this virtual viscosity, and the question of what, if any, distribution of vortices can either have no tendency to the vitiating rearrangement, or can, with the requisite fine-grainedness, be slow enough in the vitiating rearrangement to allow the propagation of waves of light to go on through a hundred million million miles of space, or a million times the earth's distance from the sun.

The Committee of the Section reported that at a meeting of the Committee it had been resolved, on the motion of Prof. Gustav Wiedemann, of Leipzig, seconded by Sir William Thomson:—"That this Committee of the Mathematical and Physical Science Section of the British Association hereby convey to Dr. Joule their sense of the great loss sustained by the Section in consequence of his inability to take part in this meeting of the British Association in his native city, and express their sincere regret at the cause of this loss, and their hearty sympathy with him in his illness. The Committee take this opportunity of recording their appreciation of the splendid work of this most painstaking and conscientious seeker after truth, who, with his discoveries, has led the way in the greatest advance in knowledge made in this age, and, by his life, has conferred on mankind a precious example for their admiration and imitation."

SCIENTIFIC SERIALS.

American Journal of Science, August.—History of the changes in the Mount Loa craters (continued), by James D. Dana. In this paper the history of Kilauea is continued from January 1840 to the end of 1886, during which period sufficient facts were accumulated for a widened and apparently final explanation of the method of filling the pit. The eruptions of 1849, 1855, 1868, and 1886 are fully described, and the whole subject is illustrated with maps of the burning mountain at various dates during the period under consideration.—On some phenomena of binocular vision (continued), by Joseph Le Conte. In this paper, the twelfth of the series, the author deals with certain peculiarities of the phantom images formed by binocular combination of regular figures. The phenomena here described, none of which have hitherto been satisfactorily accounted for, are all explained by the law of corresponding points, justly regarded as the most fundamental law of binocular vision.—Chemical integration, by T. Sterry Hunt. In this paper the author deals more fully with several points connected with chemical metamorphosis, which were more briefly noticed in his recently published work, entitled "A New Basis for Chemistry."—Studies in the mica group, by F. W. Clarke. In this paper the author deals with specimens of muscovite from Alexander County, North Carolina; of lepidomelane from Baltimore and Litchfield, Maine; of iron biotite from Auburn, Maine; and of iron mica from near Pike's Peak.

SOCIETIES AND ACADEMIES.

LONDON.

Institution of Mechanical Engineers, September 30.—Mr. E. H. Carbutt, President, in the chair.—A supplementary paper by Major Thomas English, R.E., on the initial condensation in a steam cylinder, was read and discussed in connexion with the paper by the same author on the distribution of heat in a stationary steam-engine, read at the spring meeting on May 17, an abstract of which has already appeared in NATURE (vol. xxxvi. p. 115). The supplementary experiments were carried out in a portable engine of ordinary type, the cylinder of which was jacketed on the cylindrical portion but not at the ends. The steam was admitted directly from the boiler into the steam chest, and the quantity required for each experiment being small compared with the capacity of the boiler, no question of priming or condensation before admission can arise. The connecting-rod was disconnected, and the piston was rigidly blocked at the end of the stroke furthest from the crank, the interior of the cylinder surrounding the piston-rod being entirely filled up with wood and iron packing. The steam passage between the valve seat and the end of the cylinder next the crank was also solidly filled up; and the port itself was closed by a brass plate scraped down to the level of the valve seat. The port admitting steam to the end of the cylinder furthest from the crank was left open; and the crank shaft, eccentric, and valve were driven by another engine. The steam pressure in the boiler was maintained at a uniform amount, and the regulator was kept open during a trial. The steam was measured by connecting the exhaust port with a surface condenser and collecting the resulting water. The results of the experiments appeared to indicate that the net initial condensation, or excess of condensation, over re-evaporation by the clearance surface varies directly as the initial density, and inversely as the square root of the number of revolutions per unit of time. The paper was discussed, and was followed by one on irrigating machinery on the Pacific coast, by Mr. John Richards, which dealt very fully with the forms of pumps required for the various services to be performed. The discussion of this paper was adjourned.

Paris.

Academy of Sciences, September 26.—M. Hervé Mangon in the chair.—On the recent waterspout in Lake Geneva, by M. H. Faye. In reply to M. Ch. Dufour's letter stating that several persons had noticed an *ascending* gyratory movement in the waterspout that swept over Lake Geneva on August 19, the author points out that, although the movement is really descending, as he holds against most meteorologists, there is nothing remarkable in this apparent contradiction, which is due to a purely optical illusion on the part of the observers. In the same way the spirals of a vice or screw, placed vertically to a horizontal base, when turned in the reverse direction, seem to the spectator to ascend along the line of the main axis, presenting the appearance of continually retiring from the base upwards, and burying itself in the handle or top cross-piece. The cause of the illusion is simple enough. Each anterior semi-spiral is successively replaced, as the screw revolves, by the posterior half, which, being at a higher level, the visible half-spirals, taken separately and together, seem to ascend. So with waterspouts, which, as already repeatedly explained, never ascend, but always descend, being the result of forces having their existence in the upper atmospheric regions.—On the measurement of the forces brought into play in the flight of a bird, by M. Marey. Anatomy shows that nearly all the muscles acting on the wing serve to lower it, while the kinematic data drawn from photo-chronography show that during this lowering of the wing the mass of the bird is upheld against gravity and propelled forward against the resistance of the air, the result being flight. The author here studies these two elements of the motor power separately, whence may ultimately be deduced the sum total of the motor power.—Remarks accompanying the presentation of vol. xiii. of the "Mémorial du Dépôt de la Guerre," by General Perrier. This volume is occupied exclusively with the operations connected with the extension of the geodetic and astronomic lines from Spain to Algeria.—Observations of Brooks's comet (August 24), made at the Observatory of Algiers with the 0·50m. telescope, by MM. Trépied, Rambaud, and Sy. The observations extend over the period from September 10 to 16, and give the positions of six comparison stars of the eighth and ninth magnitudes.—Observations of the same comet at the Observatory of Lyons with the 0·18m. Brunner equatorial, by M. Le Cadet. The observations cover the period from September 13 to September 21.—Positions of Barnard's comet (of May 12, 1887) and of Palisa's new asteroid (September 21, 1887), measured at the Observatory of Besancon, by M. Gruey. The observations of the comet run from June 13 to July 23. Those of the asteroid were taken with the 8-inch equatorial on September 23.—On the relative distances of the planets in relation to the sun, and on the distances of the periodical comets, by M. Delauney. The planetary distances being represented by the formula $D = 86^{1·0669^n}$, where n receives the successive values 1, 2, 3, 4, ... , the unity of distance is the semi-diameter of the sun, and if this unity be changed and the distance be taken, for instance, of the earth from the sun, the formula becomes $D = 0·0032680 \times 86^{1·0669^n}$. The calculation shows that with this same unity the mean distances of the six known periodical comets from the centre of the sun may be one presented by the analogous formula $D = 1·8940 \times 1·1511^{2^n}$. Further considerations show that there exists a gap in the series corresponding to $n = 1$, and that seven comets may be regarded as forming a single group analogous to the minor planets of the solar system. The distances increase so rapidly with n that for $n = 6$ we get 15,455, corresponding to a periodicity of nearly 2,000,000 years. Other considerations lead to the inference that the periodical comets appear to be produced by the cosmic matter of the zodiacal light.—Researches on the spheroidal state, by M. E. Gossart. The author here seeks to determine by calculation and experiment the meridional semi-section of any liquid drop whatsoever in a state of calefaction on a horizontal plaque. It is shown that there exists a characteristic form of the spheroidal state, which may easily be represented graphically according to a given scale. The measurements of the various elements of these curves may furnish useful information on the capillary constant.—On the distillation of citric acid with glycerine, MM. Ph. de Clermont and P. Chautard. The product of the process here described presents absolutely the same properties as the pyruvine obtained by distilling a mixture of tartaric acid with glycerine, although it seems difficult to explain how the same substance should result from the distillation, in the presence of glycerine, of an acid such as citric acid, which differs so greatly from tartaric acid.—On the development and structure of young Orobanches, by M. Maurice Hovelacque. Since M. Caspary's observations on the germination of the Orobanches (*O. cruenta, O. ramosa, O. minor, O. Hederæ*), dating from 1854, nothing was published on the subject till its study was resumed by Koch in 1883, the results being published in a comprehensive memoir recently issued by him. In the present communication M. Hovelacque indicates several important points where his own observations differ considerably from the conclusions of the learned German botanist.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Exercises in Quantitative Chemical Analysis, including Gas Analysis: W. Dittmar (Hodge).—Weather Charts and Storm Warnings, 3rd edition: R. H. Scott (Longmans).—Proceedings and Transactions of the Royal Society of Canada for 1886, vol. iv. (Dawson, Montreal).—Report of the Voyage of H.M.S. *Challenger*, vol. xxi. 2 Parts, Zoology.—An Elementary Treatise on Kinematics and Dynamics: J. G. Macgregor (Macmillan).—Key to Todhunter's Conic Sections: Edited by C. W. Bourne (Macmillan).—Handbuch der Palæontologie, 1 Abth. Palæozoologie, 3 Band, 1 Liefg. (Williams and Norgate).

CONTENTS.