through the universe by spirals the pitch of which is equal to the time the light takes to go round the universe. The stars are thus represented at different epochs separated by æons.

De Sitter's massless continuum is, on the other hand, represented by a hyperboloid of one sheet with its time axis vertical, and lines of shortest length now represent the stars while the movement of light through the universe is represented by a straight line generator in which a tangent plane to the asymptotic cone cuts the surface. As this cannot intersect a geodesic a second time, there is no repetition of the representation, and as the geodesics themselves change their distances apart as they travel over the surface, the universe must be either expanding or contracting.

Neither the gravitational universe of Einstein nor the non-gravitational one of De Sitter corresponds sufficiently closely with the facts, but the later one of Friedman and Lemaître, according to which space is spherically bounded and the boundary expands with time, is much more satisfactory. The radius of space is about 10^{27} cm. and the total mass it contains is about 10^{27} that of the earth, possibly due to 10^{80} particles.

In the atom the electrical forces between its constituents are about 10^{40} times the gravitational, a ratio which may have some connexion with the square root of the number of particles in the universe. The wave-length associated in wave mechanics with the electron, when multiplied by the constant known as the fine structure constant (1/137), gives the radius of the electron and when divided by it the radius of the atom. The product of the wave-length of the electron wave by the square root of the number of particles gives the radius of the universe and when divided by it the gravitational radius of the electron.

Although in this theory the appearance of the square root of the number of particles in the universe can be understood, there still remains considerable obscurity with regard to the wave-length of the electron wave and the fine structure constant.

Science News a Century Ago

John Phillips at King's College

When Lyell in 1833 resigned the chair of geology at King's College, London, he was succeeded by John Phillips (1800–74), the nephew of William Smith. Phillips began his courses of lectures on April 21, 1834. The science of geology, he said, was of but recent growth and it was necessary that students should be cautious as to the reception of theories; many of the theories which had been introduced were the results of imagination rather than the deduction of actual observation. Nothing was to be received as truth but what was warranted by actual observation and diligent research. If the science were pursued with strict attention to these preliminary principles, the benefits which would arise to those who pursued it would be commensurate with their desire of truth. In the course of his remarks, he described the primary, secondary and tertiary deposits and explained the position of the various strata of rock. He directed attention to the incontrovertible fact that in the various strata fossils had been discovered including many thousands of species of animals and vegetables which were no longer found in the animal and vegetable kingdoms by which the surface of the earth was covered, and deduced from this fact that it was obvious that the system of Nature had in the revolution of ages undergone many changes. He reminded the students of the high eminence to which their fellow countrymen had exalted the science and begged them to remember that the philosophers of the Continent had their eyes upon their proceedings and success.

Honours for Men of Science

Shortly after the first meeting of the British Association, William IV conferred the Guelphic order of knighthood upon David Brewster, Charles Bell, John Leslie, John Herschel and other men of science. In the spring of 1834, the subject of honorary distinctions for eminent scientific persons was discussed in the House of Commons, the discussion leading "Vindex" on April 22, 1834, to address a letter to the editor of the *Times* mentioning one or two points which he considered had been overlooked. In the first place, he said, the Guelphic order of Hanover, the only one conferred so far, was one of the lowest on the Continent. The title of knight could not be assumed until the recipient had been to court, and as this could not be done under an expense of nearly £200, several persons whom it had been intended should be honoured had been unable to stand this expenditure. Secondly, the order was a 'foreign' one and after the death of King William it could not again be granted and the knighthoods already conferred would lapse. "It surely," said Vindex, "would be more becoming in the Sovereign and more worthy of the nation either to make a new order or enlarge one of the present ones so as to embrace such persons as are distinguished in art or science."

Progress in Lighthouse Illumination

In the *Mechanics Magazine* of April 26, 1834, a correspondent described a visit he had made to the National Gallery in Adelaide Street, London, where an exhibition was being held illustrating the various methods of illumination in use for lighthouses and for geodetical operations. So late as 1811, the writer said, the Eddystone lighthouse was illuminated by wax candles, while in 1812 a coal fire was still in use at the Lizard. By 1834 the general method adopted in British lighthouses included the use of oil-burning Argand lamps in conjunction with parabolic mirrors of silvered-copper. This type of illumination was stated to be due to Mr. Ezekial Walker of Lynn, who had fitted up the Hunston light on the Norfolk coast in 1778. Many kinds of vegetable and animal oils had been tried with Argand lamps, but spermaceti had been found to be the most suitable. Coal gas had been tried in some foreign lighthouses, that at Dantzig having been lit by gas in 1819.

After referring to the introduction by Arago and Fresnel of the plano-convex lens in French lighthouses and to the Cordovan lighthouse at the mouth of the Garonne, then the finest in the world, the writer said that, as lenses of more than 15 inches diameter were not easily made, the lens system would not have found the favour it had but for "the discovery of our distinguished countryman Sir David Brewster that by surrounding any lens with a series of glass rings of a particular curve, it might have its effect magnified to any given extent". Other methods of illumination shown included a primitive form of arc light and the hydro-oxygen limelight of Lieut. Drummond, which gave a light "only inferior to the sun itself".

Botanic Garden, Oxford

"It is much to be regretted that the city of Oxford has not a botanic garden suited to the rank which it holds as a British university. Were a small sum contributed by each of the colleges yearly, even the present garden might be rendered doubly efficient: more especially if the adjoining ground at present occupied by Mr. Penson, were added to it, and a part, or the whole of the meadows of Christ Church. But the situation is altogether bad; and, for a botanic garden worthy of Oxford, a dry, open, ample, airy piece of ground should be selected outside of the town; say, somewhere about Jeffery's Nursery. The present botanic garden might still be continued as such, on a smaller scale, so as to suit the income destined for its support. Till lately there has been a great want of botanical taste among the Oxford professors; but hope that a taste for botany, as well as a taste for geology, is now dawning upon them; and, whenever it does, they will soon produce a botanic garden worthy of themselves. After a botanic garden is established, a zoological garden will follow; and, perhaps, ultimately, a public ornamental garden surrounding the whole city as a breathing zone." (J. C. Loudon, *Gardener's Magazine*, April, 1834.)

Societies and Academies

LONDON

Physical Society, March 2. A. O. RANKINE: A simple method of demonstrating the paramagnetism and diamagnetism of substances in magnetic fields of low intensity (see NATURE, **133**, 150, Jan. 27, 1934). A. M. FERASAH: Anomalous changes in temperature due to thermionic emission in the filaments of valves. In some valves the steady filament temperature is lower when the anode is positive, as would be expected, but in other valves it is higher. This anomalous increase in temperature is due to radiation from the anode and is larger for valves which have a high anode dissipation and an anode which closely surrounds the filament. After correction for this effect has been applied, the work-function can be approximately calculated from measurements made on an ordinary valve. T. SMITH: Change of variables in Laplace's and other second-order differential equations. Transformations of variables are expressed as matrix products, the effect of transposition being particularly considered, and the results are applied to the transformation of the general second-order differential expression. MARY TAYLOR: The Appleton-Hartree formula and dispersion curves for the propagation of electromagnetic waves through an ionised medium in the presence of an external magnetic field. (2) Curves with collisional friction. Four typical frequencies have been chosen for the calculations, one from each of the classes into which the frequencies fall when collisional friction is absent, as described in part 1. The corresponding wavelengths are 80, 240, 400 and 1,000 metres. The various stages in the effect of increasing collisional friction have been found to be usefully represented by collisional frequencies of 10^5, 10^6, 10^7 c./sec. and curves are given showing the indices of refraction κ_r ($r=a, b$), and the real part and imaginary part of M_r^2 or $(\mu_r - i\kappa_r\, c/p)^2$, together with the polarisations of the basic modes as functions of the electronic density for each of the four frequencies and collision frequencies named. The process of evaluation of M_r and of the polarisation is described. The attenuation and absorption are found to be, in general, greater for the right-handed component than for the left-handed component, with the direction of magnetic field appropriate for down-coming waves in the northern hemisphere. The use of the dispersion curves in the interpretation of propagation phenomena is discussed. J. MCGARVA BRUCKSHAW: An instrument for electrical prospecting by the inductive method. In the Bieler-Watson method of geophysical surveying, in general, the horizontal field is not in quadrature with the vertical field. An instrument has been designed which will allow the horizontal field to be compared completely with the vertical field, an important feature being that the horizontal components in phase and in quadrature with the vertical field are obtained directly from the instrument readings. The apparatus has been tested on elliptically polarised fields and has given satisfactory results.

PARIS

Academy of Sciences, February 26 (*C.R.*, **198**, 777–860). C. MATIGNON and A. DE PASSILLÉ. The ammonium arsenates. An account of the preparation of anhydrous triammonium arsenate, of the dissociation of this and the diammonium arsenate. The properties of a new ammonium metarsenate are also described. MARIN MOLLIARD and ROBERT ECHEVIN: The ovarian fluid of rust (*Agrostemma Githago*) and its relations with the seminal tegument. R. DE MONTESSUS DE BALLORE: The determination of the median in the binomial function. PAUL LÉVY: The generalisation of the differential space of N. Wiener. RENÉ LAGRANGE: A class of congruences of circles. S. K. ZAREMBA: The course of the integral curves of the equation $Y(x,y)dx - X(x,y)dy = 0$ in the neighbourhood of an isolated singular point. A. KOVANKO: The structure of almost periodic generalised functions. JEAN GRÉGOIRE: Certain shock phenomena produced in differentials. R. SWYNGEDAUW: The friction couple of ball bearings. LOÈVE: The integration of Dirac's equations. Y. ROCARD: The quantic absorption of sound in gases. ARCADIUS PIEKARA and BRUNO PIEKARA: The thermal hysteresis of the specific inductive capacity and of the conductivity of aqueous solutions of gelatine. J. THIBAUD and F. DUPRÉ LA TOUR: The diffusion and absorption of positive electrons traversing matter. Experiments based on photographic methods, using the Chalenge-Lambert recording microphotometer, lead to the conclusion that positive electrons behave like negative electrons; they undergo multiple diffusions near the charged atomic centres, with progressive deceleration. G. A. BOUTRY and J. ORCEL: Remarks on the comparison of the properties of vacuum (photoelectric) cells with those containing a gaseous atmosphere. Criticism of work on the same subject by L. Capdecomme. ALB. PERRIER and MLLE. T. KOUSMINE: The longitudinal magneto-thermoelectric effects in nickel and iron. The experimental laws. From experiments with an iron-nickel couple it is concluded that, with the magnetisation parallel to the temperature gradient, the thermoelectric power is increased: normal magnetisation, on the contrary, lowers it. O. MILLER and J. LECOMTE: The infra-red absorption spectra of the stereoisomeric orthodimethyl-cyclohexanes. Since the molecular structure of these two stereoisomers is not the same, different infra-red absorption spectra would be expected, and this is shown by experiment to be the case. The Raman spectra of the