of cement kilns are mentioned. As regards the provision of shelter, Prof. Morgan points out that in the production of Portland cement the chemist is supreme, and very few stable structures are built nowadays in which it is not employed. Glass is another important material in building construction of which the manufacturer requires the continual intervention of the chemist. Chemistry is no less important in industries providing the munitions of war. As the raw materials for the latter are obtained from coal-tar, which also supplies the organic compounds necessary for the production of dyes and drugs, the latter industries become interdependent with that of munition-making. The synthesis of one dye or drug is not only important *per se*, but also frequently the incentive in the synthesis of others. Thus, since the synthetic production of indigo many other vat dyes not found naturally have been produced.

WITH reference to our note on ferro-concrete ships (NATURE, October 11, p. 114), *Engineering* for October 19 contains an interesting account of the launch of the ferro-concrete ship *Beton I.*, with illustrations from photographs. As indicated in our former note, the ship was built bottom upwards and launched in this position. On taking the water, the air contained in the structure caused the draught to be comparatively small, the water plane was therefore large, and the vessel was in stable equilibrium. On permitting some of the air to escape, the vessel sank in the water; owing to the shape of the bottom, the area of the water plane was thus reduced considerably. Ultimately a draught was reached in which the centre of gravity was above the centre of buoyancy, and an upsetting couple was established which caused the ship to turn right side upwards, in which position stable equilibrium was again attained. The uprighting, to begin with, proceeded slowly, and accelerated in the intermediate stages in which the couple was greatest, and then again more slowly. The turning took place very neatly, without any shock, and the vessel had then, of course, to be emptied of water.

AMONG the forthcoming books of Mr. Humphrey Milford, of the Oxford University Press, are the following:—"Agriculture in Berkshire," J. Orr (a survey made on behalf of the Institute in Agricultural Economic, University of Oxford), illustrated; "A Weather Calendar," Mrs. H. Head, with a bibliography; "Dr. John Radcliffe, his Fellows and Foundations," J. B. Nias; "Dynamic Psychology," R. S. Woodworth (The Jesup Lectures); "Aristotle: Meteorology," edited by F. H. Fobes; "The Principles of Acidosis and Clinical Method for its Study," A. W. Sellards; "The Self and Nature," De Witt H. Parker; "The Problem of Space in Jewish Mediæval Philosophy," I. Efros.

THE new announcements of Messrs. Longmans and Co. include:—"Rhododendrons and their Hybrids," by J. G. Millais, with coloured plates by A. Thorburn, B. Parsons, E. F. Brennand, and W. Walker; "Mysticism and Logic and other Essays," by the Hon. B. Russell; "Reality and Truth: a Critical and Constructive Essay concerning Knowledge, Certainty, and Truth," by the Rev. Prof. J. G. Vance; and "The Works Manager To-day," by S. Webb.

MESSRS. J. M. DENT AND SONS, LTD., will shortly publish in "Everyman's Library" an anthology from the works of the late Prof. William James, which will form an introduction to the writings of the philosopher. The book is edited by Prof. C. Bakewell, of Harvard University.

OUR ASTRONOMICAL COLUMN.

THE HUNTER'S MOON.—The following particulars as to the visibility of the moon during the next fourteen days may be of interest:—

Rises		Souths		Sets		Altitude on meridian
	P.M.		P.M.		A.M.	°
Oct. 25,	2.26	Oct. 25,	7.52	Oct. 26,	1.32	31
26,	2.45	26,	8.43	27,	2.57	37
27,	3. 5	27,	9.35	28,	4.22	44
28,	3.26	28,	10.28	29,	5.47	50
29,	3.49	29,	11.22	30,	7.13	55
			A.M.			
30,	4.19	31,	0.19	31,	8.34	59
31,	4.56	Nov. 1,	1.17	Nov. 1,	9.49	62
Nov. 1,	5.41	2,	2.15	2,	10.50	63
2,	6.38	3,	3.11	3,	11.39	62
					P.M.	
3,	7.42	4,	4. 4	4,	0.16	60
4,	8.49	5,	4.53	5,	0.43	58
5,	9.59	6,	5.39	6,	1. 4	54
6,	11. 8	7,	6.23	7,	1.23	50
	A.M.					
8,	0.15	8,	7. 4	8,	1.39	45

The times along the same horizontal line refer to the same appearance of the moon above the horizon.

Full moon occurs at 6.19 a.m. on October 30, and last quarter on Nov. 6 at 5.4 p.m. It may be noted that the half-moon gives only about one-tenth of the amount of light given by the full moon at the same altitude.

THE ORBIT OF COMET 1914*c*.—A definitive investigation of the orbit of comet 1914*c* (Neujmin) has been made by J. Svärdson (*Ast. Iaktt. Stockholms Obs.*, Band 10, No. 6). The comet was never very bright, but was observed during a period of 182 days, from June 27 to December 22. Corrections have been applied for the perturbations due to Jupiter, and it is concluded that the observations are best satisfied by the following hyperbolic elements:—

$$T = 1914,\ \text{July } 30{\cdot}15783 \pm 0{\cdot}13374 \text{ Berlin M.T.}$$

$$\left.\begin{aligned} \omega &= 14^\circ\ \ 2'\ 12{\cdot}5'' \pm 92{\cdot}4'' \\ \Omega &= 270^\circ\ 18'\ 26{\cdot}7'' \pm\ 3{\cdot}3'' \\ i &= 71^\circ\ \ 2'\ 18{\cdot}4'' \pm 10{\cdot}1'' \end{aligned}\right\} 1914{\cdot}0$$

$$\log q = 3{\cdot}747131 \pm 0{\cdot}000243$$

$$e = 1{\cdot}003672 \pm 0{\cdot}000296$$

The orbit is remarkable for the exceptional value of the perihelion distance; in this and other respects it shows considerable resemblance to the orbit of the comet of 1729.

MAXIMUM OF MIRA CETI.—This well-known variable star may be expected to reach a maximum about the end of the current month. The magnitude ranges from 2·0 to 9·6 in a period of about 331 days, but the period and magnitude at maximum are subject to variation. The star is now well placed for observation, crossing the meridian near midnight, and thus being above the horizon for practically the whole night. On October 20 the star was of about 4th magnitude.

BRESTER'S THEORY OF THE SUN.—In anticipation of a further volume on the constitution of the sun, Dr. A. Brester has issued the introduction and general conclusions in pamphlet form (La Haye: P. van Stockum et Fils, 1917). As is well known, Dr. Brester does not accept the general view that the surface of the sun is subject to violent disturbances, and seeks to explain solar phenomena on the basis of a relatively tranquil gaseous globe which is practically undisturbed by convection currents. The solar gases decrease in density and luminosity from the centre outwards, but on account of their opacity their light never reaches us. The photosphere is a condensation stratum which is rendered luminous in the same way as a mantle in an ordinary gas flame, while a sun-spot is a perforation through which the less luminous surface layer of the interior gases becomes visible. The varying frequency of spots is accounted for by supposing that at minimum the heat of the central nucleus is prevented from escaping by a photosphere of relatively great thickness, and that afterwards, owing to contraction, the temperature of the nucleus increases to such an extent that the photosphere becomes attenuated and subject to perforations in the form of spots and pores. Radiation from the nucleus is then facilitated, so that the photosphere again increases in depth, and eventually produces another minimum. The chromosphere, prominences, and corona are regarded by Dr. Brester as effects of a permanent aurora, which is maintained by electrons projected from the photosphere.

THE NEW PHYSICS.

COPIES have reached us of five of Prof. Levi-Civita's recent mathematical papers,[1] three of which deal directly with Einstein's theory of gravitation, and suggest some remarks on the aspect of theoretical dynamics, as it appears at present to a comparative layman unable to criticise rival theories in detail. Speaking broadly, we may say that the theory of mathematical physics is based upon a comparatively small number of fundamental differential equations. Until recently time was explicitly or implicitly treated as the independent variable, in terms of which the other variables had to be found; and all phenomena were supposed to take place in a three-dimensional Euclidian space, where we can use the formula $ds^2=dx^2+dy^2+dz^2$ for the distance between two very near points. In the theory expounded by Minkowski and others we have a different formula, $ds^2=c^2dt^2-(dx^2+dy^2+dz^2)$, where we may regard dt as an element of time, and speak of a "world-point" (x, y, z, t) determined not only by its position, but also by its age. Einstein has developed his gravitation-theory from the general expression, $\Sigma g_{ij}dx_idx_j$ $(i, j=0, 1, 2, 3)$, assumed for ds^2, where ds is an element of distance in a four-dimensional space. (It may be remarked that in the previous theory, as Minkowski pointed out, we might take dt as a variation of a co-ordinate distance; then phenomenal processes in our space might be regarded as "sections," so to speak, of a four-dimensional system.)

With Einstein's form of ds^2 we can at once use all the known geometrical theory of infinitesimal geometry in four dimensions, and, in fact, the well-known symbols of Riemann and Christoffel directly enter into Einstein's gravitation formulæ. This is a matter of mathematics merely; the most striking fact, from the physical point of view, is that Einstein has used his formulæ successfully to account for the secular motion of the perihelion of Mercury. This does not show that Einstein has said the last word on the theory of gravitation, but it does show that these post-Newtonian theories provide a calculus which gives a better image of actual facts than the purely Newtonian theory seems able to do. The more predictions the new theory can give us, which are verified by experiment, the more we shall be inclined to trust it; and this is quite independent of what we call the "real meaning" of the symbols involved. For instance, Prof. Levi-Civita's paper No. 2 seems to show that if we could produce a sufficiently strong magnetic field, we should find it inducing upon the three-dimensional space to which, so far, our intuition appears to be confined, a corresponding "curvature" measured by $1/R^2$, where R is a length. Assuming that the field is one of 25,000 gauss, the author deduces that $R=\frac{3}{2}.10^{20}$ cm., or about ten million times the mean distance of the earth from the sun. As he points out, there is little hope of testing this by experiment, but he obtains a formula for the velocity of light, $V=c_1\exp(x/R)+c_2\exp(-x/R)$, with a damping coefficient in the second term, which he suggests might come within the range of observation.

Philosophically, the trouble still seems to be about *time*, in the philosophical sense. If we could look at the universe *sub specie aeternitatis*, we might perhaps find our greatest delight in its unchangeable perfection; but so long as we are constrained by processes (even processes of thought), time, *in some sense or other*, is apparently indispensable, and if we evict it from one habitation, we may expect it forthwith to be in occupation of another. G. B. M.

[1] (1) "Statica Einsteiniana"; (2) "Realtà fisica di alcuni spazî . . ."; (3) "Sulla espressione analitica spettante al tensore gravitazionale . . ."; (4) "Nozione di parralletismo in una varietà qualunque . . ."; (5) "Sulle linee d'azione degli ingranaggi." (1), (2), and (3) are reprints from *Rendic. della R. Accademia dei Lincei* (Rome, 1917); (4) from *Rendic. del Circ. Mat. di Palermo* (Palermo, 1917); (5) from *Attie Memorie della R. Accad. di Padova* (Padua, 1917).

METEOR ORBITS.

A PAMPHLET on "The Determination of Meteor Orbits in the Solar System," by G. von Niessl, has just been published in Smithsonian Miscellaneous Collections (vol. lxvi., No. 16, Washington, 1917). The pamphlet is a translation by the late Cleveland Abbe of a paper published in the "Encyclopädie der mathematischen Wissenschaften," dated Vienna, 1907. The author, who has had considerable experience in computing meteor paths and orbits, gives his views as to the mathematical treatment of the subject. He indicates the best method to be followed in determining the radiant and geocentric velocity of meteors and fireballs of which multiple observations have been obtained. Not the least interesting part of his discussion is that in which he deduces the mean errors in the results:—

Mean error of azimuth = 5·8°, 351 observations.

Mean error of apparent altitude = 4·1°, 235 observations.

Mean error of radiants = 3·3°, 43 cases, 537 observations.

Mean error of inclination = 6·5°, 250 observations.

The radiant positions of the chief periodical showers he gives to within 1° of probable error.

Tables are furnished of the average terminal velocity and altitude of meteors, from which he concludes that they "can penetrate deeper into the atmosphere in proportion as they move with a low velocity"—a fact previously well ascertained. With regard to atmospheric resistance, von Niessl's opinion is that direct observations make it probable that the velocity of meteors in the upper atmospheric regions is slighter, while in the lower strata of the air it is greater, than theoretical views.

The masses of fireballs and shooting-stars are discussed from various data. Prof. A. S. Herschel dealt with this part of the subject many years ago, and held the view that a first magnitude meteor is usually a few grams in weight, while the very small meteors are only the fraction of a gram. V. F. Sands found from the Leonids of 1867 that the average mass, or weight, of a meteor equal to Jupiter in brightness was 0·67 gram, while a fourth magnitude object was only 0·006 gram.

Von Niessl finds it necessary to assume decidedly hyperbolic orbits for the majority of meteors, for their "observed geocentric velocity far exceeds the limits for parabolic orbits. Therefore the large meteors in general are undoubtedly of interstellar origin." Schiaparelli arrived at similar conclusions half a century ago.

The paper is an instructive contribution to the litera-