for the purpose; the melting point of gold (1064° C.) was taken as the standard of reference. Pure palladium was found to melt at 1541° C. and pure platinum at 1745° C. Dr. Harker's recent determination of the melting point of platinum gave a value of 1710° C.

IN spite of its importance as a fundamental physical constant, the latent heat of fusion of ice is known only very approximately. The value obtained by Bunsen was 80·03 cal., whilst Regnault found it to be 79·25 cal. In the *Journal de Physique* (vol. v., p. 157) M. A. Leduc points out that Bunsen's result is subject to an error due to an incorrect determination of the density of ice at 0°. A re-determination of this constant gave a value of 0·9176, and a re-calculation of the latent heat of fusion from Bunsen's data, using this value, gave a result of 79·2 cal. This is in close agreement with Regnault's determination. The principal difficulty experienced in determining the density of ice is in eliminating gas bubbles completely. M. A. Leduc describes an arrangement by which he was enabled to minimise this source of error.

SOME remarkable specimens of phosphorescent calcite from Joplin, Missouri, are described by Mr. W. P. Headden in the April number of the *American Journal of Science*. Some of the crystals, after being exposed to sunlight, were found to become highly phosphorescent, and to retain this property for a period of thirteen hours. The specimens of calcite which showed prolonged phosphorescence were always yellow in colour, and contained 0·007 per cent. of ceria, 0·012 per cent. of the didymium earths, and 0·013 per cent. of yttrium and erbium; the spectrum of the latter was very distinct. Purple-coloured specimens of calcite found in the same neighbourhood were shown to owe their colour to the presence of didymium, and to differ from the yellow calcite in being non-phosphorescent. So far as the analytical evidence goes, the phosphorescence of the yellow calcite seems to be associated with the presence of earths of the yttrium group.

A NUMBER of foliaceous and fruticose lichens collected by Mr. A. W. C. Herre on the Santa Cruz peninsula, in proximity to San Francisco, are described by him in vol. vii. of the Proceedings of the Washington Academy of Sciences. Parmelia is an important genus, as the species are both numerous and conspicuous; *Parmelia enteromorpha* is a characteristic lichen of the red-wood forest, and *Parmelia Herrei* provides a new species. The new species *Gyrophora diabolica* forms in its locality, the Devil's Cañon, the dominant feature of the lichen rock-flora; another interesting species is the lace lichen, *Ramalina reticulata*, that festoons the oaks. The writer has drawn up a useful key for the determination of genera, and keys to the species.

A PUBLICATION just received from the Harvard College Observatory describes in detail, and with examples, a telegraphic cipher code devised by Mr. W. P. Gerrish, of that observatory. Numerous advantages are claimed for this system over other systems now in use, its chief characteristic being the ready transmission of groups of figures in a form at once simple to dispatch and readily translatable. A test of the system between the Harvard and Lick observatories gave great satisfaction.

MESSRS. ARCHIBALD CONSTABLE AND CO., LTD., will publish shortly a new book by Prof. H. C. Jones, of the Johns Hopkins University, entitled "The Electrical Theory of Matter and Radio-activity."

MESSRS. DAWBARN AND WARD, LTD., are preparing a new issue of their "Directory of Photographic Dark Rooms," and will be glad to receive from photographers information as to any public dark room not included in their directory.

SOME of the natural attractions of Norway are described in an illustrated booklet just received from the Albion Steamship Co., Ltd., Newcastle-on-Tyne, containing the itinerary of fortnightly pleasure cruises to the Norwegian fiords by the steam yacht *Midnight Sun*. The cruises are arranged so that passengers may see the most interesting scenery on or near the fiords from the Ryfylke to the Romsdal, and ample time is allowed for excursions away from the ship.

MR. C. L. MULLER has published a pamphlet giving an illustrated description of Dr. Looser's double thermoscope and some of the experiments possible with it. The instrument is an ingenious form of differential thermometer in which great sensitiveness is secured, and so arranged that it is possible to use it in making quantitative determinations. The booklet contains instructions for the performance of fifty-seven experiments in which the thermoscope can be employed.

OUR ASTRONOMICAL COLUMN.

THE EXPECTED RETURN OF HOLMES'S COMET.—From the observations of Holmes's comet in 1899–1900, Dr. H. J. Zwiers has computed a set of elements of the comet's path and an ephemeris for the probable reappearance of the object during the present year.

Having computed the elements for the epoch 1899, Dr. Zwiers applied the Jupiter perturbations for the period January, 1899, to April, 1906, and for January 16·0 (G.M.T.), 1906, found the following elements:—

$M = 351\ 46\ 52''\cdot14$	$\phi = 24\ 20\ 25''\cdot55$
$\pi = 346\ 2\ 31\cdot63$ (1906·0)	$\mu = 517''\cdot447665$
$\Omega = 331\ 45\ 40\cdot75$ (1906·0)	$\log a = 0\cdot5574268$
$i = 20\ 48\ 53\cdot30$ (1906·0)	

The ephemeris computed from these elements extends from May 1 to December 31, 1906, and is given, for every alternate day, in No. 4085 of the *Astronomische Nachrichten*.

According to the above elements, the perihelion passage should have taken place at March 14·1804 (G.M.T.), 1906, but, in a supplementary table, Dr. Zwiers gives the ephemeris corrections which will become necessary should it occur either four days earlier or later.

THE LUMINOSITY OF THE BRIGHTER STARS.—An interesting discussion of the luminosity of the brighter stars is published by Mr. George C. Comstock in No. 3, vol. xxiii., of the *Astrophysical Journal*.

Of twenty-five stars discussed, the brightest in the heavens, Mr. Comstock finds that twenty-two have luminosities less than 1000, whilst three, β Crucis, Rigel, and Canopus, have luminosities *greatly* exceeding this value, the luminosity of the sun being taken as unity.

In Mr. Comstock's opinion, this irregular distribution of values and the enormous excess of the three exceptions above the mean value render it unlikely that the parallaxes hitherto accepted for these three stars are entirely trustworthy, for it is on them that the values obtained for the luminosities are based.

Surveying the whole discussion, Mr. Comstock arrives at the conclusion that there is no adequate evidence that the maximum of stellar luminosity exceeds 1000, and, further, he opines that the mean luminosity of first-magnitude stars is not less than 100.

THE VARIABLE RADIAL VELOCITY OF ϵ AURIGÆ.—In No. 4084 of the *Astronomische Nachrichten* Dr. H. Ludendorff discusses the variable radial velocity of the star ϵ Aurigæ.

The variability of this object was discovered by Fritsch in 1821, and its variable velocity by Vogel and Eberhard in 1902.

The present discussion is based on the measurements of

twenty-six plates obtained between November 9, 1901, and March 23, 1905, with the No. iv. spectrograph and the 32·5 cm. refractor of the Potsdam Observatory.

The values obtained for the velocity, referred to the sun, vary between +5·3 km. (on November 9, 1901) and −16·9 km. (on December 11, 1902).

EARLY OBSERVATIONS OF EROS.—No. 10, vol. liii., of the Harvard College Observatory Annals contains the details of a number of observations of Eros made at Harvard from twenty-one photographs obtained during the period 1893 (October) to 1896 (June).

The measurements of these plates were published in Circular No. 51 of the observatory, but in the present publication the whole of the data relating to the plates, the original measurements of the photographs, the positions of the standard stars employed, reproductions of the photographs, and many other important matters are dealt with in great detail.

As this number forms the concluding part of vol. liii. of the Annals, several reproductions previously given in the text are now reproduced on plates in a much more satisfactory manner, and published as an appendix.

OBSERVATIONS OF SATELLITES IN 1904 AND 1905.—In No. 94 of the Lick Observatory Bulletins Prof. R. G. Aitken publishes the results of the observations of satellites made at Lick during 1904 and 1905.

Forty-seven observations of the satellites of Uranus were made, the position angle and distance of each object being referred to those of another satellite.

The second part of the publication refers to the observations of Saturn's satellites during 1905, which were, in some measure, a continuation of Prof. Hussey's work in previous years. Only those combinations most likely to improve our knowledge of the orbits of the inner satellites, *i.e.* Rhea with Dione, Tethys with Enceladus, and, as a check, Tethys with Rhea, were, however, measured. Four eclipses of Saturn's satellites were also observed.

Observations of Jupiter's fifth satellite, made during 1904 and 1905, referring this object to the three inner satellites, form the subject of the concluding section of the Bulletin.

NEW VARIABLE STARS IN ORION.—From a study of the Heidelberg 6-inch plates, Prof. Max Wolf has discovered seven new variables in Orion.

Photomicrographic reproductions, through a microscope, of the regions containing the stars on the 6-inch plates are given, together with the positions and observed variations of the seven objects, in No. 4085 of the *Astronomische Nachrichten*.

RECENT ADVANCES IN SEISMOLOGY.[1]

THE most remarkable development in modern seismology is not the seismic survey of a city, or even of a country, but of the whole world. This branch of inquiry is now in active progress. Since the time of the great earthquake of Lisbon in 1755 it has been known that disturbances of the magnitude of that event, although not directly recognisable as earthquakes in regions distant from the origin, have nevertheless given evidence of commotion by causing the water in lakes and ponds to oscillate. By observing and timing the movements of the bubbles of sensitive levels, astronomers have recorded unfelt pulsatory movements of the ground which they showed to be the result of seismic disturbances in far distant countries. In Japan these unfelt movements have been automatically recorded since 1884 (Seis. Soc. Trans., vol. x., p. 6). They were recognised to have originated at a great distance, but the centres from which they sprang were not determined. Some years later, while seeking for a gravitational influence of the moon, the late Dr. E. von Rebeur-Paschwitz found on his records abnormal movements, several of which he traced to definite but very distant seismic centres. Before this, indeed, it had been predicted that a large earthquake occurring in any one part of the world would produce movements which, with proper instruments, would be recorded in any other part,[2] but it was not until after von Rebeur's announcement that serious attention was directed to what has proved to be a line of research open to workers in all countries. Many instruments have been designed to record these unfelt breathings of our earth, but there is still much uncertainty in the interpretation of all their records.

Observations also show that large earth-waves are from time to time propagated over the whole surface of the globe. These far-reaching commotions lead to the inference that their originating impulse must have been delivered over a large region. Harboe has shown that within a meizoseismic area blows of varying intensity have been struck in quick succession at points long distances apart. A district appears to have given way, not simply along the line of one large fault, but along many minor faults. Oldham estimated that the Assam earthquake of 1897 had been accompanied by the bodily displacement of 10,000 square miles of country along a thrust plane. If we interpret the time observations made in connection with this disturbance in the light of the suggestion made by Harboe, then this relief of seismic strain originated over an area of 500,000 square miles.

Although a large block of the earth's crust may thus be fractured, our knowledge of the depth to which the effects of fracturing descend is largely one of inference. From the observations hitherto published, which are now in progress at Przibram, it would seem that a seismogram obtained at a depth of 1150 metres differs but little from one obtained on the surface. This is contrary to observations on small earthquakes, which, although they may alarm the inhabitants of a town and shatter chimneys, may pass unnoticed in shallow mines.

The fact that the large earth-waves have what is practically a constant arcual velocity of approximately 3 km. per second, whether the path be across continents, over ocean floors, or over districts which vary greatly in their geological structure, suggests the idea that the crust of the earth is moved as a whole, and that under the influence of its own elasticity and gravity it behaves in a manner similar to a sheet of ice upon an ocean swell. An alternative view is to assume that the wave motion is due to energy retained within the crust itself, the heterogeneity of which is superficial. Whichever be the case, we may picture a crust yielding irregularly, and possibly through its total thickness, until it gives up its energy to a medium which transmits undulatory movements with uniform velocity.

Many hypotheses have been adduced which suggest thicknesses for the superficial covering of our globe. To these as an outcome of recent seismological research we may add one more. Preceding the large waves of a teleseismic disturbance we find preliminary tremors. These are apparently propagated through the body of the globe with an average speed along paths which are assumed to be chords at about 10 km. per second. This high and nearly constant rate of transmission, however, only obtains for paths which represent arcs greater than 30°. For chords which lie within a depth of thirty miles the recorded speeds do not exceed those which we should expect for waves of compression in rocky material. This, therefore, is a maximum depth at which we should look for materials having similar physical properties to those we see on the earth's surface. Beneath this limit the materials of the outer part of this planet appear rapidly to merge into a fairly homogeneous nucleus with a high rigidity. Following closely on the heels of the preliminary tremors, but in advance of the large undulations, a second phase of motion appears, the chordal velocity of which up to distances of 120° is approximately 6 km. per second. These are tentatively regarded as the outcrop of distortional waves. When these are better understood it may be expected that they also will play their part in shedding fresh light upon the physics of the earth.

I will now turn to a consideration of the regions in which these sudden accelerations of geological change are in operation. They may be grouped as follows:—

Regions which lie on the western suboceanic frontier of the American and the eastern frontier of the Asiatic continents, and regions which lie on a band passing from the West Indies through the Mediterranean to the Himalayas.

In addition to these there are two minor regions, one following the eastern suboceanic frontier of the African continent, which I have called the Malagasy region, and

[1] Abridged from the Bakerian Lecture delivered by Prof. John Milne, F.R.S., at the Royal Society on March 22.

[2] See "Earthquakes," p. 226, International Scientific Series, 1883.