and dictionary of all the principal Malayo-Polynesian dialects, and am trying to reduce the whole to a uniform system of orthography. S. J. WHITMEE

Samoa, Jan. 3

The Visible Horizon

A POINT of some scientific interest has just been argued in the High Court of Justice. It was contended by the Solicitor-General that the three miles' limit of territorial waters was of modern origin, and by Sir R. Phillimore that it was due to that being the distance a cannon ball would reach from the shore. There can, however, be no doubt that the limit was recognised long before the invention of gunpowder.

Three miles is the distance of the *offing* or visible horizon to a person six feet in height standing on the shore. It is natural to suppose that the early maritime peoples of Europe would lay claim to the sea as far as the eye could reach. This distance they would find by experience was just *three miles*, and it can be proved mathematically to be correct. Measured by this standard—a tall man, usually taken as six feet high—the distance is invariable for all time, places, and peoples; measured by a cannon ball, it is constantly varying, and now ought to be five miles rather than three. The fact that the distance depends on both ocular and mathematical demonstration, and is not subject to improvement in gunnery, is the best explanation of its origin and application. B. G. JENKINS

Dulwich, May 8

Lunar Maps

LOHRMAN'S complete map, three feet in diameter, four sections of which were published in 1824, has been recently engraved by J. A. Barth, of Leipzig, under the supervision of Dr. Schmidt, director of the Athens Observatory, who has contributed a descriptive letterpress.

Schmidt's own map of six French feet diameter, will be issued before the end of the present year, from the *atelier* of the Royal Prussian Staff, the Prussian Government having, with great credit to itself, purchased that incomparable work. It is the result of thirty-four years' labour, and contains about 34,000 craters and an equal number of hills, besides over 350 rills and other objects. The difficulty of noting and correctly mapping this amazing number of lunar formations will be understood by anyone at all acquainted with the subject; and it will be seen that Dr. Schmidt has completed an achievement not surpassed in scientific capability and perseverance. A written text will accompany the map.

It were to be wished that our own countryman, Mr. Birt, could look forward to a similar recognition of his services. His great lunar map, of which we have heard nothing for some time, is on a plan quite different from Schmidt's, to which it would be found, if completed, an invaluable accompaniment by observers of the lunar surface; and it will speak but little for the scientific taste of our country if Mr. Birt's work is allowed finally to collapse for want of appreciation and encouragement.

Millbrook, Tuam, Ireland J. BIRMINGHAM

OUR ASTRONOMICAL COLUMN

THE STAR-LALANDE 27095 (BOOTES).—Olbers, writing to Bode in July, 1804, respecting his observations of the comet of that year, remarks of Lalande 27095, near the place of which star the comet was situated on March 22: "Ist nicht mehr am Himmel zu finden." It was observed by Lalande as a seventh magnitude, 1795, May 25 ("Histoire Céleste," p. 164), centre wire at 14h. 42m. 10s.

The star was observed by Bessel, 1828, May 24, as a 9th magnitude, and is No. 976 of Hour xiv. in Weisse's second catalogue. In the "Durchmusterung" it is 9·0. There is evidently reason for supposing the star to be variable.

It follows the sixth-magnitude-star B.A.C. 4906, 19s., and is 6′ 37″ north of it, the position for the beginning of the present year being R.A. 14h. 45m. 56s., N.P.D. 52° 6′·5.

THE FIRST COMET OF 1743.—Notwithstanding the very marked deviation of the orbit of this comet from a parabola, it does not appear that any attempt has yet been made to determine, directly from the observations, the true form of the orbit, or at any rate to work out elements which will satisfy the observations within their probable limits of error. It is true that these observations, with one or two exceptions, are by no means exact, and Olbers, who examined the question in 1823, was of opinion that, from their general uncertainty, an investigation into the nature of the conic section described was hardly worth the trouble it would involve. Notwithstanding this expression of opinion from so high an authority, it may be remarked that there are a sufficient number of observations in our possession which cannot fairly be supposed liable to serious errors to justify an attempt to deduce more satisfactory elements than those hitherto calculated.

The comet appears to have been first observed by Grischow or Grisso, at Berlin, on February 10, and his observation on the evening of that day was considered by Olbers to be the most certain of any he made upon this comet, and not liable to a greater error than 2′ or 3′. On February 14, 15, 16 and 19, Grischow, observing apparently with Margareta Kirch, also gives particulars from which probably fair positions might be deduced. And we have an observation by Father Frantz, of Vienna, on February 21, given in proper form in the "Philosophical Transactions" of the Royal Society. Also a good observation by Maraldi at Paris on February 13, and one by Cassini on February 17, which last, however, is open to some doubt, not only for a reason pointed out by Olbers, but from an error as to the comparison star. Zanotti's observations at Bologna, form the longest series, and extend from February 12 to 28, but they are only published (in *Mémoires de l'Academie*, 1743) in longitude and latitude to minutes of arc, without further detail, and were not given by Zanotti as having any pretensions to accuracy. The parabolic orbit with which Olbers was content to discontinue his computations was the following:—

Perihelion Passage, 1743, Jan. 10, at 20h. 29m. 37s. Paris M.T.

	°	′	″	
Longitude of perihelion	92	57	51	
,, ,, ascending node ...	67	31	57	
Inclination to ecliptic	2	16	16	
Perihelion distance...	0·83818			(Earth's mean distance = 1)

These elements agree well, according to Olbers, with the positions observed on Feb. 10 and 28, and with the longitudes on Feb. 13 and 21, but the latitudes on these days differ by 14′ and 10′ respectively, which is precisely the kind of discordance, which we might expect to find, if the true orbit of the comet were an ellipse of short period. It will be remembered that Clausen considered this comet identical with that of November 1819, detected by Blanpain at Marseilles, with a period of 6·73 years before 1758 and 5·60 years after 1817, and that at the suggestion of Olbers the perturbations were calculated at the Collegio Romano to the year 1836, when the comet had been expected to re-appear. The orbit of short period which appears in catalogues with Clausen's name, was calculated from Zanotti's observations of Feb. 12, 20, and 28, with a pre-supposition as to the length of the major-axis. As already remarked, no attempt, so far as we know, has yet been made to deduce elements direct from the observations, which shall represent them with smaller errors than the parabolic orbits of Lacaille, Olbers, and Struyck.

Grischow records that on the evening of Feb. 11, 1743, the apparent diameter of the comet was 18′, that it appeared like a greyish-white cloud, but with close attention, "ein kleines helles Pünctlein in der Mitte gewahr." We find by calculation that the comet at this time was distant from the earth only 0·051 of the earth's mean distance from the sun, and are reminded that such an object would have afforded an opportunity of the kind to which Mr. Marth has lately adverted, for a determination of the amount of solar parallax. A similar opportunity may recur at any time, and, as is most probable, very suddenly; we can only hope that observers will be equal to the next occasion.

THE MINOR PLANETS.—Of the members of this group, in addition to the four older ones, Ceres, Pallas, Juno, and Vesta, at present favourably placed for observation, the brighter are Hera, Iris, and Melpomene; Hera and Melpomene are a little below the tenth magnitude, and Iris about 9·5. The following are approximate positions for Greenwich midnight:—

	Hera. R.A.	Hera. N.P.D.	Iris. R.A.	Iris. N.P.D.	Melpomene. R.A.	Melpomene. N.P.D.
	h. m. s.	° ′	h. m. s.	° ′	h. m. s.	° ′
May 20	16 45 53	104 11	16 56 25	114 5	15 29 27	92 15
,, 24	16 42 26	104 5	16 52 28	113 53	15 25 36	92 3
,, 28	16 38 52	103 59	16 48 22	113 40	15 21 50	91 54
June 1	16 35 15	103 54	16 44 10	113 26	15 18 14	91 48

THE GREENWICH TIME SIGNAL SYSTEM

IN NATURE for April 1 of last year (vol. xi. p. 431) we gave a description of the new Sidereal Standard Clock of the Royal Observatory at Greenwich. Fundamentally important as is this clock in all that concerns its relation to exact astronomical science, it performs also another and more immediately practical duty, that of regulating the time of great part of the United Kingdom. And we propose now to trace the connection existing between this purely astronomical clock and those by which the daily business of our lives is arranged.

A few words of preliminary history may not be uninteresting. Formerly, when, comparatively speaking, little communication existed between the people of different towns, each place kept its own local time. But when railways began to be extended through the country in all directions, such manner of reckoning time could not with any regard to convenience be followed in arranging the movements of trains. The adoption of one uniform system of counting time having, as regards railways, thus become a necessity, all towns in connection with railways, as a matter of convenience, fell sooner or later into the same system, one now universally followed. The time of the meridian of Greenwich is that employed. This selection was probably in part accidental. The railway authorities, when seeking for uniformity, would naturally be led to take as standard the time of the most influential place, and so adopt metropolitan time, which happens to be, practically, Greenwich time. But however this may be, the selection was for another reason a happy one. The meridian of Greenwich is that from which longitudes are counted on all British maps, and Greenwich time having been already long used by the navigator, means of obtaining a proper knowledge of it at seaports was very desirable. Its adoption for railways by facilitating the after-introduction of the time-signal system as now existing was therefore a fortunate circumstance.

The regular exhibition of accurate time for public use, by any kind of authoritative signal, was commenced at Greenwich in the year 1833, when the first time-ball was erected on the eastern turret of the ancient portion of the Observatory buildings, principally for the purpose of giving Greenwich time to chronometer makers and seamen. It has been dropped every day since the year mentioned, excepting only during some periods of repair, and occasionally on days of violent wind. The ball, which is about five feet in diameter and painted black, is by mechanical means raised half-way up its mast at 5 min. before 1h. as a preparatory signal; at 3 min. before 1h. it is hoisted to the summit. It drops at 1h. true Greenwich mean solar time. Formerly it was discharged by an attendant who, watching a clock the error of which had been previously ascertained, pressed the ball-trigger at the proper instant, but since the year 1852 it has been discharged by automatic means, as will be explained further on. The first start of the ball, or its separation from the cross (indicating the cardinal points) immediately above, is very sudden, and is the phase to be noted; afterwards (to avoid injury to the building), a piston, connected by a long rod to the ball, falls into a nearly air-tight cylinder, and so checks its descent that it comes gently to rest at the foot of the mast.

Within a few years of the establishment of the Greenwich ball, others were erected at British observatories near to ports and harbours, as Edinburgh, Liverpool, Glasgow, &c., principally also for the service of shipping. And such signal balls or equivalent means of exhibiting time are now to be found at many observatories abroad, as for instance at the Cape of Good Hope, Madras, Bombay, Sydney, Melbourne, Mauritius, Quebec, Washington, &c. Originally such time-balls could only be dropped at an observatory or institution at which time was determined by celestial observation, but on the introduction of the electric telegraph an observatory could be made the centre of a system from which, by galvanic means, time-balls could be dropped at, or time-signals given to, distant points.

On the first establishment of the electric telegraph in England, the connection of the Royal Observatory with the telegraphic system and its possible application to the daily distribution of time throughout the kingdom soon engaged the attention of the Astronomer Royal, but before things had come to any definite shape, the scheme for laying a submarine cable between England and France was proposed, and active steps taken to carry it out. The progress of this work was watched with interest by astronomers on both sides of the channel, and some of the active members of the Institute of France having expressed their earnest desire to take advantage of the new cable for galvanic determination of the difference of longitude between the Observatories of Paris and Greenwich, the Astronomer Royal became enabled in the year 1852, principally with the assistance of Messrs. E. Clark (of the then existing Electric Telegraph Company) and C. V. Walker (of the South-Eastern Railway Company), to establish the long-desired communications on the English side. The application of the telegraph to the direct determination of longitude will not, however, further concern us at present. As soon as telegraphic connection with the Royal Observatory was complete, the system of transmitting time signals from Greenwich for distribution by the Electric Telegraph Company on their lines was commenced, special apparatus having been for the purpose prepared both at Greenwich and London. This we now proceed to describe.

The Mean Solar Standard Clock of the Royal Observatory, the principal clock of the whole time-signal system, erected in the year 1852 specially for the work, is always kept adjusted as nearly as possible to exact Greenwich mean time. It is a clock of Shepherd's construction, with seconds pendulum, and is maintained in action by galvanic means alone. But it works others sympathetically. The wire which carries the galvanic currents from the pendulum to the electro-magnets to drive the hands is continued, before returning to the battery, to other electro-magnets in connection with the hands of other dials in different parts of the Observatory building, so that the hands on all the dials advance simultaneously, the forward motion of the whole system depending entirely on the one pendulum of the standard clock. Of these various clocks, one is fixed in the boundary-wall of the Observatory; it is daily consulted by great numbers of people, and will be familiar to every visitor to Greenwich Park. Several are placed in the Chronometer Room for use in the daily comparison of the Royal Navy and other chronometers, the difference between the time shown on one of these dials and that of any chronometer giving immediately the error of the chronometer without further calculation. Other dials are to be found in different office rooms in which accurate time is necessary. All these