come welling out from beneath the sea and from rocks on the shore in most of the bathing-places and elsewhere. Some difference of opinion exists as to the condition of the underground waters in such districts, in particular as to the existence of subterranean basins filled with water up to a certain level as distinct from underground rivers, and Dr. De Marchi discusses Grund's views in this connection. There is in southern Italy another Karst region in the arid portions of Puglia, but in this case the fissures are much smaller, and the author here finds conditions under which the bed of water is not much above the sea-level.

MR. A. GRANGER, the chief inspector of weights and measures for Birmingham, has written a pamphlet entitled "Our Weights and Measures" (published by Messrs. Eyre and Spottiswoode, price 6*d*.), suggesting certain modifications of the imperial system of weights and measures with a view to its simplification. He appears to be of opinion that such a radical change as the displacement of our weights and measures by the metric system is not practicable, and his plan is to modify the present system so as to make it as convenient and rational as possible. His proposal involves the introduction of a new pound weight equal to half a kilogram, which for all ordinary purposes means an increase of the present pound by 10 per cent., and a new gallon, also 10 per cent. greater than the present one, practically equivalent to 5 litres, or $\frac{1}{2}$ dekalitre. This would not disturb the plan of the imperial system; for example, the legal definition of the gallon as containing ten imperial pounds of distilled water would still hold good. His idea is ingenious, but it seems probable that if any change is effected in our weights and measures it will be in the direction of adopting the metric system in its entirety, rather than modifying the present imperial units.

THE investigation which M. Guillaume, of the Bureau International des Poids et Mesures, Paris, has been conducting into the changes undergone by steels used as length standards has shown results of interest to engineers and scientific workers (*La Nature*, January 6). Briefly summarised, his conclusions are as follows:—The most important point in connection with the use of steels in the tempered state for the preparation of standards of length is that of the "stabilisation" of the steel. It may be said generally that between 0° and 100° C. the transitory variation in length (like that in glass or in the nickel-steels) is proportional to the square of the temperature. With stoving carried to a high limit of duration, the total variation between 0° and 100° C. is about .5 microns. At ordinary temperatures this variation is only of the order of a small fraction of a micron per metre length. For tempered steels stoved for only a short time, the transitory variation is much greater. To conclude: as regards tempered carbon-steels, the variations of all kinds before stoving are appreciable and rapid, but can be so minimised as to cease to be prejudicial to the use of such steels for industrial end standards.

THE *Times Engineering Supplement* for January 26 is the annual review number, and contains much interesting matter relating to the progress of engineering in 1916. Experience has accumulated during the past year regarding the features of ship-construction which are calculated to enable a ship to remain afloat after torpedo or gunfire attack. Longitudinal subdivision, while practicable in warships at great cost, is impracticable in an ordinary cargo vessel, and it is considered doubtful whether transverse water-tight subdivision would enable a cargo ship to resist torpedo attack. While merchant vessels can be greatly improved to protect them from torpedo attack, considerations of design, economy of construction, and carrying and earning power make it preferable to arm the ship. This is the course which will probably be adopted in the new tonnage now building. In America, owing to the enormous demands on the steel industry, it has been found impossible to keep abreast with the demand for shipbuilding material. This has led to a revival of wooden shipbuilding, and a number of wooden hulls are now being constructed in the Seattle district and at various points on the Pacific Coast.

THE *South African Journal of Science* for October, 1916, contains a report of the address to Section B (Chemistry, Geology, Metallurgy, Mineralogy, and Geography) of the South African Association for the Advancement of Science by the president of the section, Prof. J. A. Wilkinson. The address deals with two general questions: first, the organisation of the South African Union for the fuller development of its industries and resources, and, secondly, the necessity of research in order to develop existing industries and establish new ones. Dealing with the first question, Prof. Wilkinson points out that hitherto South Africa has existed on its raw materials, which are exported whilst articles manufactured from them are imported He gives a long list of imported articles, the most important being coal products, earthenware, glass, cement, condensed milk, paper, sugar products, oils, fats, and waxes, and medicinal preparations which could be manufactured from the natural resources of the colony. Some of these are, in fact, manufactured there, but the quality is not so good as that of the imported articles, and this is stated to be due to the lack of effective chemical control in the industries. It is urged that South Africa is not sufficiently self-contained, and that the necessity of establishing chemical industries with *chemists*, not merely engineers and business men, in control is vital. With regard to the second question, the position of the tannin bark industry of Natal now (tannin was synthesised by E. Fischer and K. Freudenberg in 1913) is compared with that of the natural indigo industry in 1880, when indigo had been synthesised in the laboratory, but the long period of development which made it a commercial success was only beginning. It is argued that had as much time and money been spent on the scientific investigation of natural indigo as were spent on the synthetic dye, the vegetable product would have been placed beyond competition. The lesson afforded by indigo should be applied to the case of tannin. Prof. Wilkinson considers that the prime mover in research must be the State, and submits a comprehensive scheme for its inception and organisation.

OUR ASTRONOMICAL COLUMN.

COMET 1916*b* (WOLF).—The following ephemeris of this comet, for Greenwich midnight, is given by Dr. Berberich in *Astronomische Nachrichten*, No. 4870:—

		R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness
Feb. 2	...	17 9 0	−5 1·4	0·4406	10·5
10	...	26 5	4 19·9	0·4182	12·3
18	...	17 43 36	3 27·0	0·3951	14·5
26	...	18 1 31	2 22·1	0·3716	17·0
Mar. 6	...	19 48	−1 5·3	0·3476	20·1
14	...	38 26	+0 23·5	0·3235	23·8
22	...	18 57 22	2 4·0	0·2995	28·1
30	...	19 16 34	+3 55·1	0·2758	33·1

The brightness is expressed in terms of the brightness at the time of discovery, 1916, April 3. It is probable that the comet will become a naked-eye object during the summer.

INVESTIGATIONS OF STAR CLUSTERS.—Further results of an extensive investigation of the magnitudes and colours of stars in clusters, which is in progress at Mt. Wilson, have been given by Dr. Harlow Shapley (Contributions from the Mt. Wilson Solar Observatory, Nos. 115, 116, and 117). The problems presented by clusters are stated in the first paper, while the second and third deal respectively with the globular cluster in Hercules, and the open cluster M37.

In the case of the Hercules cluster, a catalogue of 1300 stars has been prepared, involving more than 10,000 estimates and measurements of magnitude. The colour-indices suggest that there is no appreciable selective scattering of light in space in the direction of the Hercules cluster, but the apparent increase of redness towards the centre would seem to imply an absorption within the cluster itself. There is an almost linear decrease of colour-index with decreasing brightness in all regions of the cluster, and this feature will probably have great significance in regard to the evolution of giant stars. A conclusion of special interest is that the parallax of the Hercules cluster must be less than 0·0001″, and is probably greater than 0·00001″. At the provisionally adopted distance of 100,000 light years, the cluster would be more than 1000 light years in diameter. As viewed from the cluster, our sun would appear fainter than the 22nd magnitude, and our entire galactic system would have an angular diameter of about 5°, perhaps comparing closely in general appearance with the Greater Magellanic Cloud as seen from the earth. It is probable that no star so faint as the sun has yet been photographed in this cluster, and that a large number are more than 200 times the solar brightness. Dr. Shapley considers it reasonably clear that the Hercules and other similar clusters are very distant systems, distinct from our galaxy, and perhaps not greatly unlike it in size and form. The open clusters, on the other hand, seem to be relatively small parts of the local system.

It is interesting to note further that five new variables have been discovered in the Hercules cluster, making a total of seven now known. It is probable that all of them are of the Cepheid type.

THE ALMANAC OF THE MADRID OBSERVATORY.—The issue of this publication for 1917 contains the customary astronomical information, ephemerides, and tables, with the necessary explanatory matter. In addition, there is a useful article on the spectroscopic classification of stars, by Prof. Iniguez, with photographic illustrations, and a very full account of the methods of determining latitude. Details of the meteorological observations and of the observations of sun-spots, faculæ, and solar prominences made at the Madrid Observatory occupy nearly 300 pages of the volume.

SOUND-AREAS OF GREAT EXPLOSIONS.

IT is not often that a great explosion occurs near the centre of a populous area, and the recent disaster in East London thus offers an opportunity of adding to our knowledge on the transmission of sound-waves by the atmosphere. A brief summary may first be given here of the results obtained in recent investigations. The most remarkable result is the recognition of the fact that there exists sometimes, not always, a zone of silence which separates two detached sound-areas. This zone has been traced in twenty recent explosions (excluding that of Friday, January 19), two being due to gun-firing, four to explosions of dynamite or gunpowder, and the remainder to volcanic explosions in Japan.

The source of sound is always unsymmetrically placed within the inner sound-area, and nearly always lies on the side facing the outer sound-area. On this side the boundary of the inner area may be as near as 2½ miles, or as distant as thirty-nine miles, from the source. The most important dimension, however, is the radius, or mean radius, of the curve which forms the outer boundary of the zone of silence. It is far from being constant. It may be as low as fifty miles, as with the minute-guns fired at Spithead on February 1, 1901, or as high as ninety-nine miles, as with the Wiener-Neustadt explosion of 1912.

During the four years 1909–13 eleven explosions of the volcano Asamayama, in central Japan, have given rise to double sound-areas, in most of which the outer area is the larger. The inner area is arranged with a rough approach to symmetry about the ash-precipitation zone. This is usually a long narrow band, the direction of which is determined by that of the higher air-currents into which the smoke-cloud from the volcano rises. The direction of the band is usually towards the east, but varies between north-east and south-east, and it is a significant fact that, as Prof. Omori has pointed out, the centre of the outer sound-area is usually on or close to the continuation westwards of the ash-precipitation zone. Of twenty-two important explosions of the Asamayama from December, 1909, to the end of 1913, Prof. Omori notices that single sound-areas occur just as frequently as double sound-areas. Nine of the former occurred in the six winter months, and ten of the latter in the six summer months. On the theory that the zone of silence is due to the refraction of the sound-rays by winds varying in velocity, and sometimes also in direction, with the altitude, Mr. S. Fujiwhara has shown that, with the normal type of winter weather in Japan, the sound-areas would be single, and with that of summer weather, double.

With regard to the distance to which explosions may be heard, it would be well to separate those in which the sound-areas were single from those in which they were double. Of the first class, the explosion at Avigliana (northern Italy) in 1900 was heard at Lugano, ninety-nine miles distant. The explosion in the same year at Kobe (southern Japan), which probably belongs to this class, was heard at ninety-seven miles. Of explosions with double sound-areas, the distances are ninety miles for the Hayle (Cornwall) explosion of 1904, about 112 miles for the Förde (Westphalia) explosion of 1903 and the Jungfrau railway explosion of 1908, and 186 miles for the great explosion at Wiener Neustadt in 1912.

Though later accounts may modify some of the dimensions given below, a first analysis of the reports already received shows that the explosion in East London on January 19 belongs to the class with double sound-areas. The inner area is of unusual form, being L-shaped, with the angle near Godalming, the east-and-west limb reaching to Canterbury, and the north-and-south limb to the neighbourhood of Northampton. The least distance of the boundary of the inner area from the source of sound is about twelve miles, and the greatest distance sixty-five miles.

The outer sound-area lies to the north of the other, with its centre a few miles west of King's Lynn. Its longer axis (131 miles in length) reaches from the neighbourhood of Nottingham to that of Lowestoft, its width being about fifty-five miles. The zone of silence varies in width from sixteen miles (near Northampton) to fifty-four miles, and the distance of its outer boundary from the source is about sixty miles. So far as is known at present, it includes the greater part of Essex and Suffolk, the southern half of the counties of Cambridge and Huntingdon, and the central portion of Northamptonshire. Even if observations should be received afterwards from this area, it is significant that, from the inner sound-area of about