OUR ASTRONOMICAL COLUMN.

THE 100-IN. REFLECTOR AT MOUNT WILSON.—Some years ago the Mount Wilson Observatory ordered from France a 100-in. diameter mirror, the French foundry being the only one in the world which would undertake the casting of such a large mass of glass. The mirror, when delivered in California, was found not to be up to the standard of contract quality, and the French firm undertook to set about casting a new one. In the meantime, as an experiment, it was decided to figure the disc, and Prof. Ritchey worked away at it in the workshop at Pasadena. On the completion of his task, it appears from a note in *The Observatory* (March) that the tests have shown that the mirror is practically useless. It will be some time before the more perfect disc is procured, but it is hoped that the second attempt will be quite successful.

SOLAR RADIATION DURING THE ECLIPSE OF APRIL 17, 1912.—In the form of an extract from the *Comptes rendus de la Société Scientifique*, of Warsaw, we have received a paper in which Dr. W. Gorcynski describes the observations of the insolation made at Warsaw during the partial eclipse of the sun which occurred on April 17, 1912. The diminution of the solar radiation readings began about half an hour before the eclipse, and remained below the normal for the date for nearly the same time after. The maximum reduction of the solar radiation attained 89 per cent. at Warsaw, where 0·88 of the disc was covered at maximum phase, and the radiation curve agrees fairly well with the phase curve. Between noon and 4 p.m. each sq. cm. of surface received 110 great calories, at normal incidence, less than usual, and the drop in temperature, as recorded in the screen, was between 2° and 3° C.

BANTU STAR NAMES.—No. 12, vol. xii., of *Man* contains an interesting article by Miss A. Werner discussing the names by which the stars are described in Bantu by the tribes of Nyasaland. Miss Werner's general impression is that nearly, if not quite, all the peoples with whom she has come into contact have lost much star knowledge which they once possessed. The name for the Pleiades is always etymologically connected with agriculture, being derived from a root, *lima*, meaning "to cultivate," thus indicating that the Zulus, Swahilis, &c., have employed this asterism, as have so many other primitive races, as a substitute for the modern calendar. The "belt" stars of Orion seem always to be connected with hunting, and the name for Venus conveys generally the idea the planet is the moon's wife. The names applied to Jupiter also suggest a connection with hunting, a native explanation being that a hunting expedition should start on a night when Jupiter is overhead just before dawn. Several other of the names given are of special interest, and tend to show that the astronomical observations of primitive races are essentially utilitarian in character.

THE EXPLOSION OF WORLDS.—Some interesting speculations as to the possibility of such a world as the earth being shattered by the explosive energy of the now pent-up internal forces are published by Mr. Hudson Maxim in the February number of *The Fortnightly Review*. Among other things, he shows that the pressure of the earth's crust is so great that the most powerful explosive known, in any quantity, would fail to do more than shake it locally. Gravitational pressure is so enormous that were two solid steel balls, as large as the earth and as hard as the Harveyised surface of armour-plate, gently placed in contact they would flow together like water, and could have no variation from a true sphere greater than fifty miles high. By such arguments Mr. Maxim demonstrates the enormous strength and rigidity of the terrestrial sphere, and shows that it is immune from the effects of any shattering force less than the collision of the solar system with another celestial system.

THE DETROIT OBSERVATORY.—The first issue of the Publications of the Astronomical Observatory of the University of Michigan (vol. i., pp. 1–72) contains, *inter alia*, a most interesting account of the observatory and its work. The observatory also makes seismographic observations, and the records of the earthquakes recorded from August, 1909, to January, 1912, are given in the present publication.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE meetings of the Institution of Naval Architects opened on Wednesday, March 12, in the rooms of the Royal Society of Arts. During the three days over which the meetings extended, fourteen papers were presented for discussion. The gold medal of the institution for 1912 was presented to Admiral Sir Reginald Custance, and premiums were awarded to Prof. Gümbel and to Mr. A. Cannon. The Marquis of Bristol, in his presidential address, referred to the loss the institution had sustained in the death of Sir Wm. White, and hoped that some memorial of a permanent character would be instituted by the various societies with which he had been connected, and that such memorial might take a form of practical service to the profession.

Mr. D. B. Morison gave some interesting data regarding the influence of air pumps on the military efficiency of turbine-driven warships. According to the latest cruiser practice, a vacuum of 28·5 in. is required at full power in sea water at 55° F. If, under conditions of maximum and constant generation of steam in the boilers, the vacuum falls from 28·5 to 27·5 in., then the loss in power is about 6 per cent. The minimum capacity of an air pump is determined by the quantity of air in the feed water as it enters the boiler, without provision for insidious leakage. From his experience with high-vacuum plants of the highest class, Mr. Morison does not believe that ideal air-tightness can be maintained under the severe conditions of war; hence the necessity for the provision of an air margin in the capacity of the air pumps. Various types of air pumps are discussed in the paper.

Sir Charles A. Parsons states in his paper on mechanical gearing that such gearing for reducing the speed between the turbine and the propeller is now well advanced beyond the experimental stage. This type of gearing is now in service on vessels representing a total of 26,000 h.p., and there are others under construction aggregating 120,000 h.p., including two installations of more than 20,000 h.p. each. The Channel steamers *Normannia* and *Hantonia* continue to show an economy, as compared with other turbine steamers of somewhat different design on the same service, of about 40 per cent. The *Normannia's* gearing, inspected recently, shows no signs of wear. Comparative coal consumption trials have been carried out on a cargo steamer, built for the Cairn Line, and fitted with turbines and mechanical gearing, and on a sister ship, the *Cairngowan*, with exactly similar boilers and propeller, but with triple expansion engines. The coal was of the same quality, and measured in the same way on both ships, and the geared turbine ship has shown a saving of 15 per cent. in the coal consumption. So far, no limit in regard to the surface speed of the teeth in the gearing has been discerned, and there is no evidence of any limit to the power that can be transmitted by

mechanical gearing with gear-wheels suitably designed. Careful investigations have been made of the causes producing noise in the gearing, and show that the noise is due to slight inaccuracies in the teeth; it should be noted that the noise is an engine-room noise only, and is not perceptible elsewhere. This has led to a method of cutting the gear-wheels, which greatly reduces the errors involved in reproducing the parent gear. Two rotating tables are used in the new machine; the wheel to be cut is fixed to the upper one, and is given a creep in advance of 1 per cent. in relation to the motion of the lower table; the lower table is driven by worm-gearing at 1 per cent. less speed than would be the case if a single table were employed; hence the wheel on which the teeth are being cut has a motion compounded of the motion of both tables, and equal to that required for the given number of teeth to be cut. This device has the effect of causing the errors in the teeth to lie in very oblique spirals around the wheel, and also reduces the errors themselves. In the actual machine, the errors are reduced to about one-fifth of the original magnitude.

Mr. W. Reavell contributed a paper on the use of compressed air for working auxiliaries in ships propelled by internal-combustion engines. It is of interest to note, in the operation of deck winches in cargo steamers, that although steam at a pressure of 90 lb. per sq. in. may be supplied, the actual pressure demanded by the winches in working did not exceed 16 lb. per sq. in. Earlier attempts to deal with such cargo-hoisting problems with high-pressure compressed air have been wasteful; modern installations in which air at low pressure is used for operating the winches have been successful and economical.

Baron A. Roenne contrasted the advantages and disadvantages of airships and aëroplanes, and gave a suggested design for an airship 853 ft. in length and 72 ft. 3 in. in diameter, having a displacement of 104 tons at 0° C., and 760 mm. of mercury. A speed of fifty-two miles per hour could be obtained with 2000 h.p., and it should be possible to carry a regular passenger service and to master the air on almost every day of the year.

In a paper on the longitudinal stability of skimmers and hydro-aëroplanes, Mr. J. E. Steele states that the most notable machine in the aëroplane show at Paris this year from the point of view of inherent longitudinal stability was one designed by M. Drzewiecki. The principle embodied in this design is that of difference in pressure intensity on the forward and the after curved planes, due to the different cross sections. On the involuntary rising of the front part of the machine, the increase in the angle of attack has quite a different effect on the fore to what it has on the rear plane. The pressure per sq. ft. on the front plane is but very gradually increased for changes of the angle of attack between the limits of 5° and 18°, whereas that on the after plane increases very rapidly with the angle at which the wind meets it. The result is an excess of lift aft, which restores the machine to its original position. The converse holds if the front of the machine is involuntarily depressed. The reduction in the angle of attack leaves the pressure on the front plane but slightly altered, but reduces quickly that on the rear plane, resulting in a drop of that part to the normal position.

Mr. G. S. Baker gives the first published account of systematic research work carried out at the William Froude tank at the National Physical Laboratory. The experiments had for their object the testing of the effect upon the resistance of the ship of varying the relative lengths of the entrance to run (*i.e.* those portions of the bow and stern respectively which are clear of the perfectly parallel midship body), maintaining the same general form, water-line, and principal dimensions. Five parent models have been chosen, and with each of these, four or five proportions of entrance and run have been tried. Another set of experiments has been carried out with the view of testing the effect upon model resistance of various possible terminations to the lines, both in fore and after body. The alterations tried have affected both the area curve and the water-line, and, in addition, the effect of the presence of the rudder has been tested in one case.

Mr. C. E. Inglis contributed a mathematical paper dealing with the stresses in a plate due to the presence of cracks and sharp corners. Exact results are obtained for the distribution of the stresses around a hole in a plate, the hole being elliptic in form. If the axes of the ellipse are equal, a circular hole is obtained; by making one axis very small the stresses due to the existence of a fine straight crack can be investigated. One of the several results obtained may be quoted. A strip of plate of indefinitely great width is pulled in the direction of its length, the tensile stress intensity being R. There is an elliptic hole in the plate having major and minor axes, $2a$ and $2b$ respectively, and arranged so that the major axis is at right angles to the pulls. At the edge of the hole situated at the extremity of the major axis, a tensile stress occurs having an intensity $R(1+2a/b)$. This stress decreases rapidly as we proceed along the section of the plate made by producing the major axis, and, at a short distance from the edge of the hole, attains the normal value R. It will be seen that the maximum value becomes very large if b is made small; if $a/b=1000$, the maximum tensile stress has a value of 2001 times the intensity of the mean stress. In this case the ellipse would appear as a fine straight crack, and a very small pull applied to the plate across the crack would set up a tension at the ends sufficient to start a tear in the material. The increase in the length due to the tear exaggerates the stress yet further, and the crack continues to spread in the manner characteristic of cracks.

A paper on the distribution of stress due to a rivet in a plate, by Prof. E. G. Coker and W. A. Scoble, is also of considerable interest. In a former paper measurements have been described of the differences of principal stresses at points in plates having notches and holes of various kinds. In the majority of the former cases, the stress distributions were such that the minor principal stresses vanished or were of little importance. In many practical problems, both principal stresses are of considerable magnitude, and it is then important to obtain each stress separately. The present paper describes a general method for determining both the sum and the difference of the principal stresses at a point in a plate, considered as averages taken over the normal at the point, and bounded by the two faces of the plate. The stress difference may be measured directly by mechanical or optical means, advantage being taken in the latter method of the fact that plates of glass, celluloid, and like transparent bodies, become temporarily doubly refractive when stressed, and that in polarised light there is, in consequence, a relative retardation, R, between the ordinary and extraordinary rays, which is proportional to the stress difference, and to the thickness T of the plate. If p_r and p_t are the magnitudes of the principal stresses, the law is given very approximately by $R=c(p_r-p_t)T$, where c is an optical constant. The sum of the principal stresses may be determined by taking advantage of the fact that a plate, when subjected to stresses in its own plane, alters in thickness. Thus, if both stresses p_r and p_t are pulls, there is a lateral contraction of amount $(p+p_t)T/mE$, where m is Poisson's ratio

and E is Young's modulus. Hence by determining m and E and also by measuring the changes in thickness of a stressed plate, the sum of the principal stresses may be evaluated as an average throughout the thickness of the plate. Having obtained the sum and difference, it is a simple matter to state the values of p_r and p_t separately. A new form of instrument is described in the paper, specially devised for measuring small changes in thickness of a stressed plate. This instrument is partly optical, readings being obtained by means of a ray of light reflected from a mirror which is rotated partially by the strain to be measured. One millimetre on the scale is equivalent to two millionths of an inch change in the lateral dimensions of the specimen. A number of experimental determinations are given in the paper and show very concordant results.

COLLOIDS AND THEIR VISCOSITY.

SPECIAL interest attached to the meeting of the Faraday Society, held on Wednesday, March 12, in view of the distinguished foreign guests who took an active part in the proceedings. These included Prof. Pauli (Vienna), Dr. Wolfgang Ostwald (Leipzig), Prof. Victor Henri (Paris), Prof. Freundlich (Brunswick), and Prof. Nernst (Berlin).

The meeting took the form of a symposium upon colloids and their viscosity, and the afternoon session was opened by Dr. Wo. Ostwald, who, in an introductory address of a general character, showed the importance of viscosity measurements as a means of study of the colloidal state. In the course of his remarks, which were fully illustrated with examples, he laid special stress upon the need for kinetic, as opposed to static, methods for the investigation of heterogenous systems, and in this connection also emphasised the value of viscosity measurements. An illustration of this principle was immediately afforded by the communication of Profs. Freundlich and Ishizake on the rate of coagulation of $Al(OH)_3$-sols as measured by the viscosity change, the results of which were in complete accord with those of Paine upon copper oxide-solutions, using a totally different method. The following empirical formula proved to express the experimental results of coagulation by potassium salicylate with great exactness :—

$$dx/dz = 2Kz(1+bx)(1-x)^2,$$

where K is a constant depending on the concentration of the electrolyte, z represents time, and x the amount of precipitated particles, the latter taken as proportional to the increase in viscosity. From the equation in its more general form,

$$dx/dt = K_1 f(U)(1-x)^2,$$

Freundlich and Ishizake drew the following conclusions. The term $(1-x)^2$ suggests the coagulation process to be primarily a reaction of the "second order" in which the colloidal particles may be supposed to unite in pairs, the cause for which union is to be found in an asymmetry of their electric charges (expressed in the term $f(U)$) due to unequal degrees of electrolyte-adsorption. The degree of asymmetry was found to be proportional to the time z, to the number of precipitated particles, and to an exponent of c, the concentration of electrolyte thus :—$f(U) = \lambda c^q z(1+bx)$, where λ, q, and b are constants.

Prof. Pauli directed attention to the importance of viscosity measurements in the study of "emulsoid" colloids in a survey of the chief results obtained in his own school, showing what important generalisations as to the ionisation and degree of hydration of proteins in solution had been arrived at by this means. His experiments proved, for example, that at the iso-electric point, where, by definition, the ionisation of the protein is a minimum, a close correlation existed between that property and (1) osmotic pressure, optical rotation, viscosity, and imbibition of water, all of which reached their lowest value, and (2) precipitability by alcohol which was at its maximum. With increase in concentration of protein ions, caused by addition of either acid or alkali, a corresponding rise was found to occur in the value of the first set of properties and a fall in the precipitability.

The evening session was chiefly devoted to a discussion of the factors concerned in the viscosity of colloidal solutions and the interpretation to be placed upon the viscosity value. Mr. Emil Hatschek developed a mathematical theory of the viscosity of two-phase systems, showing that for "suspensoid" equally with "emulsoid" colloids, viscosity depended upon the volume-ratio of the two phases, and was independent of the size of the colloidal particles. In the case of the former, as shown also by Einstein and Bancelin, the viscosity increased in linear ratio with the volume of disperse phase, while in the case of "emulsoid" colloids the viscosity of the system was equal to $\frac{\sqrt[3]{A}}{\sqrt[3]{A}-1}$, where A = ratio : $\frac{\text{volume of system,}}{\text{volume of disperse phase}}$ the viscosity of the continuous phase being taken as unity. Experimental support was adduced in both instances, and interesting confirmation also obtained for the above formula in the case of paraffin soap-solution emulsions, where viscosity had been determined by means of Couette's apparatus, and direct measurement could be made of the volumes of both phases. Prof. Henri gave a critical survey of the various direct and indirect methods available for volume-measurement of colloidal particles. He showed that, among the indirect methods, that of Perrin (based on the distribution with depth of colloidal particles after settling), and that of Rayleigh (by measurement of the intensity of light after lateral diffusion through colloidal solutions) were among the most trustworthy, since in the formulæ used for calculation of r, the radius of the colloidal particles, the term r was raised to the third and sixth power respectively. As a result of work with $Fe(OH)_3$-sols Prof. Henri, expressed the view that apart from the question of phase-ratio, or size of colloidal particles, the *arrangement* of the latter might have a very important influence upon the viscosity of the system.

An interesting discussion followed, in which, among others, Dr. Ramsden, Dr. S. B. Schryner, Dr. McBain, and Dr. C. J. Martin took part. In the absence of the chairman, Dr. R. T. Glazebrook, the chair was taken by Mr. Emil Hatschek.

ATMOSPHERIC HUMIDITY AND TEMPERATURE.

TWO papers on the psychrometer formula, reprinted from recent Proc. Roy. Soc., Victoria (vols. xxiv. and xxv.), discuss a modification, proposed by Dr. Ekholm, of the Stockholm Meteorological Office, to be made in Regnault's formula for the wet- and dry-bulb hygrometer, which would have important consequences if confirmed. The formula so modified would be $x = \eta f - AB(t-t')$, where x and f are respectively the actual vapour-pressure and the saturation vapour-pressure at the temperature t' of the wet bulb. A is the ordinary psychrometric constant, and η the coefficient, less than unity, inserted by Ekholm to allow for a supposed diminution of vapour-pressure at the surface of the wet bulb due to hygroscopic action of the material covering it. The first paper, by Dr. E. F. J. Love