the photometric work done with it. The "Harvard Photometry," and the "Uranometria Oxoniensis" together will carry down to all time the record of the present brightness of the stars. They will be especially valuable as data for determining changes in stellar brilliancy.

During the past ten years the number of variable stars has risen from about 100 to nearly 150; and our knowledge of their periods and light-curves has been greatly improved. In America, Chandler and Sawyer, of Boston, and Parkhurst, of this city, have done especially faithful work. During the ten years we have had two remarkable "temporary stars," as they are called—first the one which, in November 1876, in the constellation of Cygnus, blazed up from the ninth magnitude to the second, and then slowly faded back to its former brightness, but to a *nebulous* condition, as shown by its spectrum; then also the one which, last autumn, appeared in the heart of the nebula of Andromeda as of the sixth magnitude (where no star had ever been seen before), slowly dwindled away, and is now beyond the reach of any existing telescope. Perhaps, too, we ought to mention another little ninth-magnitude star in Orion's club, which last December rose to the sixth magnitude, and is now fading; it seems likely, however, from its spectrum, that this is only a new variable of long period.

As to star-spectra, a good deal of work has been done in their investigation with the ordinary stellar spectroscopes by the Greenwich Observatory, by Vogel at Potsdam, and by a number of other observers,—work well deserving extended notice if time permitted. But the application of photography to their study, first by Henry Draper in this city, and by Huggins in England, is the important new step. By the liberality of Mrs. Draper, and as a memorial of her husband, his work is to be carried on with the new photographic instrument and method just introduced by Prof. Pickering at Cambridge. He is able to obtain on a single plate the spectra of all the stars down to the eighth magnitude in the group of the Hyades, each spectrum showing under the microscope the characteristic lines quite sufficiently for classification. A different instrument is also to be built with the Draper Fund, which will give single star-spectra on a much larger scale and in fuller detail.

During the decade, the stellar parallax has been worked at by a number of observers. Old results have been confirmed or corrected, and the number of stars whose parallax is fairly determined has been more than doubled. The work of Brunnow and Ball in Ireland, of Gill and Elkins at the Cape of Good Hope, and of Hall, at Washington, deserves especial mention. A new heliometer of seven inches aperture has been ordered for the Cape Observatory, and when it is received, a vigorous attack is planned by co-operation between that observatory and that of Yale College, which possesses the only heliometer in America.

During the ten years, our knowledge of double stars has been greatly extended; several observers, and most eminent among them Burnham, of Chicago, have spent much time as hunters of these objects, and have bagged between one and two thousand of them. Several others, especially Doberck in England, and Flammarion in France, have devoted attention to the calculation of the orbits of the binaries, so that we have now probably about seventy-five fairly well defined.

In the study of the nebulæ, less has been done. Stephan at Marseilles and Swift at Rochester have discovered many new ones, mostly faint, and Dreyer, of Dublin, has published a supplementary catalogue, which brings Sir J. Herschel's invaluable catalogue pretty well down to date. The studies of Holden upon the great Orion nebula and the so-called "trifid nebula" deserve special mention, as securely establishing the fact that these objects are by no means changeless, even for so short a time as twenty or thirty years; also the discovery of a new nebula in the Pleiades by means of photography.

Observatories.—During the ten years, a considerable number of new observatories have been founded. Abroad, we mention as most important the observatories for astronomical physics at Potsdam, in Prussia, and at Meudon, in France, also the Bischoffsheim Observatory at Nice and its succursal in Algiers. The great observatory at Strasburg can hardly be said to have been founded within the period indicated, but the new buildings and new intruments and new efficiency date since 1880. We ought not to pass unnoticed the smaller observatory at Natal, in South Africa, and the private establishments of von Konkoly at O-Gyalla, of Gothard at Hereny (both in Hungary), and of the unpronounceable gentleman Jedrzejewicz at Plonsk, in Poland, and the observatory at Mount Etna, from which, however, we have no results as yet.

In the United States, we have the public observatories at Madison, Wis., at Rochester, N.Y., and at the University of Virginia, and the, as yet, unfinished Lick Observatory in California: also a host of minor observatories connected with institutions of learning, and mainly designed for purposes of instruction; such establishments have been founded within ten years at Princeton, at Northfield, Minn., at South Hadley, Ms., at Beloit, at Marietta, at Depauw, at Nashville, and at St. Louis, also at Franklin and Marshall College, and at Doane College, in Nebraska, at Columbia College, Ann Arbor, and Madison, Wis., and at one or two other institutions which escape me for the moment. Several others are also at this moment in process of erection. Every one of them has a telescope from six to thirteen inches aperture, with accessory apparatus sufficient, in the hands of an astronomer, for useful scientific work.

Instruments.—A large number of new instruments of great power have been constructed. We mention the great thirty-inch refractor of Pulkowa, the twenty-six-inch of Charlottesville, and the twenty-three inch at Princeton, for all which the lenses were made by our own Clark. We add the great Vienna twenty-seven-inch telescope by Grubb, and the twenty-nine-inch object-glass by the Henrys, made for the Nice Observatory, but not yet mounted; also the nineteen-inch telescope at Strasburg by Merz. Grubb has also at present a twenty-eight-inch object-glass under way for the Greenwich Observatory, and Clark has nearly completed the monstrous thirty-six-inch lens for the Lick Observatory. There never was a decade before when such an advance in optical power has been made.

Great *reflectors* have been scarce, the only ones of much importance constructed during the time being the twenty-inch instrument at Algiers, and Mr. Common's exquisite three-foot telescope, which he has lately sold to Mr. Crossley in order to make way for one of five feet diameter, now, I believe, under construction. The old three-foot and six-foot instruments of Lord Rosse have been improved in various ways, and are still in use,—especially in work upon lunar heat. Among newly-*invented* instruments, we mention the meridian-photometer of Pickering, the wedge-photometer of Pritchard, the almucantar of Chandler, the concave diffraction-grating of Rowland, and the bolometer of Langley—all, but one, American. Repsold's improvements in the micrometer, in the heliometer, and in the mounting of equatorials should also be mentioned here.

As to new astronomical methods, enough has been already said about photometry and astronomical photography. It is plain that we are entering upon a new era.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE examination for the Sheridan Muspratt Chemical Scholarship at University College, Liverpool, will begin on December 9. The Scholarship is of the value of 50*l.* per annum, tenable for two years. Candidates should apply to the Registrar before December 6.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, November 22.—M. Jurien de la Gravière, President, in the chair.—On the life and work of L. R. Tulasne, by M. Ed. Bornet. The paper contains a somewhat detailed account of the labours of this eminent botanist, who was born at Azay-le-Rideau (Indre-et-Loire) on September 12, 1815, and died on December 2, 1885. Appended is a list of the scientific publications of MM. Louis-René and Charles Tulasne.—On ammoniaco-magnesian phosphate, by M. Berthelot. In continuation of his previous researches on the colloidal and crystallised states of the earthy phosphates, and especially of the phosphate of magnesia, the author here studies the double ammoniaco-magnesian phosphate, determining the conditions of formation of this compound in chemical analysis.—The Montgaudier Cave, by M. Albert Gaudry. The author describes a visit he recently paid to this cave, which is situated in the Charente district, and which has revealed several objects of an artistic character, dating from the close of the Quaternary epoch, when the large fauna of extinct species had already mostly disappeared. But some remains,

such as pieces of ivory embellished with carvings of the aurochs and other animals, seem to have been executed at an earlier period, while the cave-dwellers were still struggling for existence with the mammoth, with *Rhinoceros tichorhinus*, the cave-bear, cave-lion, and large hyæna.—On glycose, glycogene, and glycogeny, in their relation to the production of heat and of mechanical labour in the animal system, by M. A. Chauveau. In this first physiological study of these elements, the author deals more especially with the generation of heat in the organism while in a state of repose. The reasons are set forth which lead to his broad generalisation regarding the preponderating part played by the glycose of the blood in organic combustions, source of animal heat and of muscular energy. It is now fully established that the absorption of glycose in the capillaries during the transformation of arterial into veinous blood is connected with the respective activity of the attendant combustions in the several organs.—Some remarks on the determination of mean values, by Leopold Kronecker. It is shown that in a converging series of real terms $\phi_1 + \phi_2 + \phi_3 + \dots$ with positive real quantities $\psi_1, \psi_2, \psi_3 \dots$ increasing with n beyond all limit, the limit of the expression—

$$\frac{1}{\psi_n}(\phi_1\psi_1 + \phi_2\psi_2 + \phi_3\psi_3 + \dots + \phi_n\psi_n)$$

for increasing values of n is equal to zero.—On the movement of an indefinite and perfectly elastic fluid, by M. N. Marin. The object of this study is to complete the law of Mariotte by another described as the law of elasticity for perfectly elastic and completely free fluids. In a fluid so constituted, it is laid down that all contraction determined by any cause whatsoever acting in a single direction, is instantaneously propagated in all other directions.—On the movement of a cord in a fixed plane, by M. Appell.—On the algebraic integrals of Kummer's equation, by M. E. Goursat.—Analytical demonstration of a theorem relating to orthogonal surfaces, by M. Paul Adam. The theorem here dealt with is that of M. Maurice Lévy regarding a group of surfaces in an orthogonal system, and by him demonstrated on purely geometrical considerations.—On the unequal movement of a compressed gas in a reservoir freely discharging into the atmosphere, by M. Hugoniot.—On an apparatus by which the time may be communicated to the performers out of the conductor's sight, by M. J. Carpentier. The apparatus here described has been constructed at the request of the directors of the Paris Opera. It is based on the principle of visible signs, depending on a purely optical illusion, and producing the impression of an ordinary conductor's hand beating time. It is thus free from the defects inherent to the various electric appliances hitherto devised for the same purpose.—On a means of increasing the power of fluid and electric agencies, by M. Charles Cros. In this process a return is made to the old idea involved in the expression "electric fluid," and the wires are regarded as analogous to elongated tubes through which pressure is transmitted. The experiment was suggested by the author's researches on transmissions through more or less elastic tubes containing air or water.—On the tension of saturated vapour, by M. P. Duhem.—On the physical properties of mercury, by M. Marcellin Langlois. On the assumption of a mono-atomic molecule of mercury, the author determines its heat of evaporation, its specific heat, compressibility, and heat of fusion.—Actinometric studies, by M. E. Duclaux.—A new process of volumetric analysis for powdery zinc (*gris d'ardoise* of la Vieille Montagne), by M. Frédéric Weil. By the process here described, 100 gr. of this substance yield 65·3 gr. of pure zinc.—Action of the alcohols on the protochloride of gold and phosphorus, by M. L. Lindet. Here are described the preparation and properties of two chlauroso-phosphorous ethers—ethylic and methylic ether.—On the Russian petroleums, by M. J. A. Le Bel. The chief element of the petroleum of Baku, at the eastern extremity of the Caucasus, are naphthenes, C_nH_{2n}, and naphthylenes, C_nH_{2n-2}; and their salient characteristic is that they do not fix bromine.—On the heats of neutralisation of malic and citric acids and of their pyrogened derivatives: remarks on the numbers obtained, by MM. H. Gal and E. Werner.—On certain correlations between the modifications experienced by species of different genera subjected to the same influences, by M. Fontannes. Several analogous modifications are noted pervading many species of different genera throughout the geological record; but no theory is advanced to explain the coincidences.—On a new genus of parasitic Copepod, by M. Eugène Canu. This new genus is a parasite of the Synascidians, and abounds on the *Morchellium argus* (Milne-Edwards) frequenting the Wimereux district.—On the anomalous formations of the Menispermeæ, by M. Gérard.—Observations on the plaster added to new wines in the South of France and other parts of Europe, by M. A. Audoynaud.—Note on the coarse marine limestone formation of the Provins district (Seine-et-Marne), by M. Stanislas Meunier.—On the Devonian system of the Eastern Pyrenees range, by M. Ch. Depéret.—On the pleromorphoses of the quartz of Saint-Clément (Puy-de-Dôme), by M. Ferdinand Gonnard.—Description of a variety of Carphosiderite, by M. A. Lacroix. The optical properties of this mineral, which was found in the neighbourhood of Mâcon (Saône-et-Loire), are described.—On the conditions of form and density of the terrestrial crust, by M. A. de Lapparent. It is argued that the generally-accepted views regarding the symmetrical flattening of the globe at the poles is far from proved, and it is suggested that in the southern hemisphere there exists an inaccessible ant-arctic continent presenting a different conformation in this respect from that of the northern hemisphere.—On the mode of formation of the Newfoundland banks, by M. J. Thoulet.—On the progressive desiccation of lacustrine basins in dry climates, by M. Venukoff.

BOOKS AND PAMPHLETS RECEIVED

Die Schiffsmachine; Atlas: Bushey (Lipsius and Tischer, Kiel).—Second Armagh Catalogue of 3300 Stars: Robinson and Dreyer (Thom, Dublin).—An Arctic Province; Alaska and the Seal Islands: H. W. Elliot (Low).—Wild Animals Photographed and Described: J. F. Nott (Low).—Quarterly Journal of the Geological Society, vol. xlii. part 4, No. 168 (Longmans).—Studies from the Biological Laboratory, Johns Hopkins University, vol. iii. No. 8.—Calendar of University College of South Wales, 1886-87 (Owen, Cardiff).—Géologie de Jersey: Le P. C. Noury (Sary, Paris).—Memoirs of the Geological Survey of India—Palæontologia Indica, ser. x.; Indian Tertiary and Post-Tertiary Vertebrata, vol. iv. part 2, The Fauna of the Karnul Caves: R. Lydekker (Trübner).—Descriptive Catalogue of a Collection of the Economic Minerals of Canada: A. R. C. Selwyn (Alabaster).—L'Égalité des Sexes en Angleterre: F. Remo (Nouvelle Revue, Paris).—Theory of Magnetic Measurements: F. E. Nipher (Van Nostrand, New York).—Outlines of the Geology of Northumberland and Durham: G. A. Lebour (Lambert, Newcastle-on-Tyne).—Lehrbuch der Histologie: Dr. P. Stohr (Fischer, Jena).—Lehrbuch der Entwicklungsgeschichte, Erste Abth.: Dr. O. Hertwig (Fischer, Jena).—Lunar Science, Ancient and Modern: Rev. T. Harley (Sonnenschein).—Hourly Readings 1884, part 1, January to March.—The Auk, October, vol. iii., No. 4 (New York).—Journal of Physiology, vol. vii., Nos. 5 and 6 (Cambridge).—Notes from the Leyden Museum, Nos. 1 to 4, 1886 (Brill, Leyden).—Observations Nouvelles sur le Tufeau de Cipley: A. Rutot and E. van den Broeck (Liége).—Proceedings of the Academy of Natural Sciences of Philadelphia, April to September 1886 (Philadelphia).—The Washoe Rocks: G. F. Becker.—On the Origin of Agriculture: H. Ling Roth (Harrison).

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