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MEDALS OF THE NATIONAL ACADEMY OF SCIENCES[1]

PRESENTATION OF THE JAMES CRAIG WATSON MEDAL TO ERNEST WILLIAM BROWN

THE problems of motion in the solar system have challenged the ingenuity of the greatest mathematicians and theoretical astronomers. Of those who have contributed to their solution none has attained the precision in representing the observed positions of the moon that Ernest W. Brown has achieved in his well-known theory. In 1907 he received the Gold Medal of the Royal Astronomical Society on the completion of the literal and numerical theory.

At that time about a dozen lunar theories had been produced. Of these that of Hansen held its place in the nautical almanacs. Before Brown's theory could replace that of Hansen it was necessary for him to make his theory accessible in the form of tables. The invention and testing of practical devices for this purpose engaged him for a number of years until the tables appeared in 1920. Hansen's approximate theory included 500 terms as against Brown's 1,500 terms. An ephemeris based on his theory would have required a hundred to two hundred hours' work for a single position. The numerical operations necessary for an hourly ephemeris extending over a year would demand at least a million hours of work. On the basis of a 40-hour week and a 50-week year, medical men would have to extend the span of life of a single computer to five hundred years to enable him to accomplish the task. With the aid of the tables the task can now be accomplished by a single computer in from six to nine months.

On the achievement of this second step in his lunar theory Dr. Brown was awarded the Bruce Gold Medal of the Astronomical Society of the Pacific. His tables have been uniformly used in the nautical almanacs since 1923 and predicted the 1923 eclipse with surprising accuracy. The honors which Brown has received were prompted not only by his lunar theory, although he had made it his principal task since 1890.

[1] Presented at the dinner of the academy, Washington, D. C., April 27, 1937.

Admirable accounts of his many other achievements were printed in the *Monthly Notices* of the Royal Astronomical Society and in the *Publications* of the Astronomical Society of the Pacific on the occasion of the award of the medals.

The third stage of his lunar theory, on which Brown is still engaged, has as its main objective the explanation of the minor discrepancies which have revealed themselves between the tabulated and the actual motion of the moon. At the same time his genius has conquered a variety of other hitherto unsolved problems based on Newton's law of gravitation. All these endeavors have led to new and significant results. The award of the Watson Medal therefore is based on his notable contributions to gravitational theory in general rather than on the specific achievement of the lunar theory.

In 1907 he had produced the most accurate value of the secular term in the moon's mean motion, but there remained unexplained well-marked deviations in the longitude of a fairly systematic character. There were also unexplained departures in the motion of the perigee and of the node of the moon's orbit amounting to the really small trifles of 17″ and −12″, respectively, per century. These he has practically wiped out by the inclusion of still further significant terms in his expansions. This last achievement was an unexpected by-product of a remarkable investigation on the stellar problem of three bodies, of which the third part on the motions of the apse and node, with applications to the moon, was published as recently as last December.

In 1924 he hit upon the real character of the occasional deviations in the longitude of the moon by correlating them with those of the sun and thereby was able to eliminate a gravitational cause external to the earth for the deviation of this type of the moon, sun, Mercury and Venus. This led to the discovery of the variability of the rotation of the earth and to the establishment of the moon as a more perfect timepiece than the earth. Of greatest importance are his demonstrations of the effect of the moon on the rate of the almost perfect Shortt clocks. At present he is engaged with Professor W. J. Eckert, of Columbia University, on a new numerical verification with the use of the modern computing machines.

Among his many other achievements, time permits me to mention only a few. He has produced a successful general theory of the Trojan group of minor planets which oscillate about the third corner of an equilateral triangle with sides equal to the distance of Jupiter from the sun. This theory is outstanding as regards originality and elegance of treatment and represents the observed motions of the planets of the group more perfectly than any other.

In the more general field of celestial mechanics he has made many significant contributions, including a general theory of resonance which he has applied successfully to the explanation of the gaps in the distribution of the mean motions of minor planets. His work on the Fourier series, on the development of the perturbative functions, his special forms of separate differential equations, which made it possible to integrate independently one class of terms irrespective of the others, and other contributions mark a new epoch in the general theory of perturbations. Here should also be mentioned his theory of the eighth satellite of Jupiter. And last, I must mention his conclusion that the discovery of the planet Pluto was not based on theoretical predictions, a conclusion which he reached after a highly ingenious and strictly mathematical discussion of the conditions of this remarkable case.

Such is a brief and wholly inadequate record of our medalist's achievements. The academy may justly be proud to count him among its members and to be able to honor him by the bestowal of the Watson Medal.

A. O. LEUSCHNER

UNIVERSITY OF CALIFORNIA

PRESENTATION OF THE HENRY DRAPER MEDAL TO C. E. KENNETH MEES

IN 1872 Dr. Henry Draper secured the first successful photograph of the spectrum of a star, and he also was first to secure any photographic record of a nebula . . . the great gaseous cloud in Orion. Thus we see he was a pioneer in the application of photography to astronomy and that he was possessed of an eagerness for improved means for observing the heavens.

Dr. Draper's brilliant pioneering work was unfortunately interrupted by his untimely death in 1882, before he was privileged more than a glimpse of the great advantages the application of photography was to bring to the study of the heavens. However, his widow, wishing to stimulate growth in this new field opened by her husband, established the Henry Draper fund with this academy, and indicated ways the income of the fund might be employed to stimulate study in this new field.

It then appears peculiarly fitting that the academy in this Henry Draper award is recognizing and encouraging the development of photography as applied to astronomy. And it is a pleasure to mention some of the grounds for the academy's awarding the Henry Draper Medal, this evening, to Dr. C. E. Kenneth Mees, director of the Research Laboratory of the Eastman Kodak Company, Rochester, N. Y.

Dr. Mees has devoted his life to the development of the theory and the perfection of photographic processes and materials. His early prominent piece of

work, "Investigations on the Theory of the Photographic Processes," published in 1907 in collaboration with Sheppard, has since been a classic on the subject. This gave him wide distinction, and he was called to America in 1912, where since then he has been continuously occupied in this field of endeavor at the Eastman Kodak Research Laboratory, of which he has been the director.

Let us recall that at the beginning of the present century it was hardly possible in astronomy to photograph a spectrum range of more than about 2,700 Angström units, *i.e.*, from 3,300–6,000 A. But to-day fully twice that length of spectrum (*i.e.*, from 6,000 to 12,000 A. in the infra-red) has been added. Much of this great gain has resulted from the development of emulsions and sensitizers at the hands of Dr. Mees.

Surely we would give enthusiastic welcome to a new telescope of double the power of any existing instrument, but would not astronomy gain far more if the power of our photographic plates were to be doubled, for such would in effect be doubling the power of *all* telescopes.

But Dr. Mees's wide extension of the photographable spectrum into the longer wave-lengths carries even greater scientific importance than might at once be evident, for it brings us knowledge of a vast new portion of the energy of the stars. And this means our knowledge of the heavenly bodies may now be builded upon this broader foundation. To point an example, the successful photography of the red and infra-red of the spectra of the planets has brought new knowledge of notable value on the constitution of the atmospheres of the planets.

In accomplishing these and other advances for photography our medalist has contributed to the general progress of science, as well as to astronomy in particular. Incidentally he has built up the excellent Research Laboratory of the Eastman Kodak Company. Thus for thirty years he has carried on with marked ability and skilful technique fundamental researches.

It is, therefore, a pleasure, on behalf of the Draper Committee, to present Dr. C. E. Kenneth Mees for the high honor of the Henry Draper Award.

FRANK SCHLESINGER
YALE OBSERVATORY

PRESENTATION OF THE AGASSIZ MEDAL TO MARTIN KNUDSEN

MARTIN KNUDSEN while a very young man had an experience that largely determined his scientific activities for the rest of his life. In 1895 and 1896 he undertook the physical investigations on board the Danish cruiser *Ingolf* in the seas around Iceland and Greenland. At the time of the first expedition Knudsen was 24 years old and he said, "I was totally unacquainted with hydrographical work, and the knowledge I had occasion to acquire of hydrographical literature before our departure in 1895 was but a trifle." During the first voyage he made observations on surface and subsurface temperatures, determined the specific gravity of water samples and the amount of chlorine in them, and took samples of water in bottles and in exhausted glass ampules. During the second voyage, as the water was immediately analyzed for contained gases, it was not necessary to collect samples in evacuated glass ampules. This program sounds simple, but there were difficulties. First, the thermometers for recording subsurface temperatures were inadequate—Knudsen thereupon improved the thermometers. He discarded as too crude the attempts to determine the specific gravity of sea water by means of hydrometers and further developed the method of chlorine titration. He also developed methods for making gas analyses on shipboard, so that the needed analyses were made immediately after the water samples were collected. The data presented in the tables and the discussion of the significance of the observations are based upon the more refined methods for procuring information. The range of problems discussed is most impressive. The "Hydrography of the *Ingolf* Expedition" by Knudsen is a classic contribution to oceanography. This was the accomplishment of a young man in his twenties. The *Ingolf* report was published in 1899.

Progress in many branches of science depends upon the possession of adequate instruments, a body of established physical constants and proper procedure. The mere recognition of a scientific problem will not solve that problem. Knudsen's first oceanographic experience made him keenly conscious of the fundamental needs of physical oceanography, and he set about the development of apparatus and the determination of physical constants. His invention of standard sea water and his refinements of chlorine titration for the determination of the salinity and density of sea water over the entire range of temperatures encountered in the ocean, and the tables prepared by him to embody the results of long-continued investigations, constitute a foundation stone of modern dynamical oceanography. The tools provided by Knudsen are necessary for utilizing the equations formulated and developed by V. Bjerknes, Helland Hansen, Sverdrup, Hesselberg and others for solving problems in dynamical oceanography. This statement also applies to the numerous graphical methods of treating oceanographic data.

Knudsen has made a number of designs of oceanographic apparatus, such as a frameless water-bottle, a bottom-samples for hard bottoms and a spectro-

photometer. He has also paid fruitful attention to a number of oceanographic problems. His first papers were on the influence of plankton on the quantities of oxygen and carbonic acid dissolved in sea water. His researches in the field of low pressure phenomena in gases are better known to physicists than to oceanographers.

In addition to his activities already mentioned, Knudsen has since 1902 rendered invaluable service as a consultant in hydrographical investigations for the Danish Government and the International Council for the Exploration of the Sea.

The members of the committee that nominated Professor Knudsen for the Agassiz Medal are happy that the academy approved its recommendation. Professor Knudsen richly deserves the honor conferred upon him.

T. WAYLAND VAUGHAN

WASHINGTON, D. C.

PRESENTATION OF THE MARY CLARK THOMPSON MEDAL TO AMADEUS WILLIAM GRABAU

THE Committee on the Mary Clark Thompson Fund, meeting in 1936, decided unanimously to award the medal provided for in this fund "for most important services to geology and paleontology" to Amadeus William Grabau, professor of paleontology in the National University of China and chief paleontologist to the Chinese Geological Survey. Among the recipients of this medal since 1924, chiefly paleontologists, are C. D. Walcott, E. de Margerie, J. M. Clarke, J. Perrin Smith, W. B. Scott, E. O. Ulrich, David White, F. A. Bather and, in 1934, Charles Schuchert.

The committee noted the distinguished services of Professor Grabau in general and stratigraphic geology, in the science of non-metallic mineral deposits and particularly in paleontology. His paleontological researches cover the Paleozoic of New York and during the last seventeen years the paleontology of China. The results of this work are contained in a splendid series of monographs on Chinese Paleozoic and also Mesozoic fossils, the last volume of which was published like the rest by the Academia Sinica, in Peking.

Professor Grabau was born in Wisconsin in 1870. He studied first in the Massachusetts Institute of Technology, where he served as instructor from 1892 to 1897. After obtaining his Sc.D. at Harvard in 1900 he served as adjunct professor at Columbia University, 1902–1905, then as professor from 1905 to 1919. In 1920 he was appointed to the two important positions in China mentioned in the first paragraph of this address, and he has remained there for the last seventeen years working unceasingly and most successfully on the paleontology and geology of China. His contributions are fundamental and exhaustive. And this in spite of severe physical handicaps during later years which would have discouraged any man with less courage and energy. Among his characteristics are an indomitable nature; a faculty of inspiring others with his enthusiasm; an ability to plan and carry out the work to which he has devoted his life.

The work of Professor Grabau is incorporated in a long series of publications. In 1910 he published in collaboration with another distinguished paleontologist, Professor H. W. Shimer, of the Massachusetts Institute of Technology, a widely used book on "North American Index Fossils." Later came "Succession of Faunas in the Middle Devonian in U.S.A."; the "Hamilton Fauna of Michigan"; "The Phylogeny of Invertebrates, Chiefly Gastropods"; "Principles of Stratigraphy" (second edition in 1921); "Textbook of Geology," 2 volumes, 1921; "Nonmetallic Deposits," 2 volumes, 1922; "Ordovician Fossils of North China," 1921; "Stratigraphy of China," 1925; and last but not least the succession of volumes referred to above and published by the Academia Sinica under the general heading, "Paleontologia Sinica." Besides these there are a great number of shorter papers. Enough of an accomplishment, one might say; enough to fill a long life.

I feel sure you will agree with me that in presenting this medal we are paying a just tribute to a most distinguished paleontologist and geologist who has brought honor to American geology to the four corners of the earth.

We regret deeply that Professor Grabau is unable to be here in person, but rejoice that we may entrust the medal to Mrs. Grabau, who is here with us to-night and who will transmit the token to Professor Grabau with our admiring regards.

WALDEMAR LINDGREN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ABSTRACTS OF PAPERS PRESENTED AT THE WASHINGTON MEETING OF THE NATIONAL ACADEMY OF SCIENCES

A catalogue of neurohumors: G. H. PARKER. Neurohumors are hormones produced by the secretory portions of the nervous system or by glands immediately associated with this system and serving as means of activating other parts of the nervous system and its effectors, such as muscles, glands, chromatophores and the like. Neurohumors are well illustrated by adrenalin, a secretion of the adrenal gland, and by intermedin, a product of the