THE NATIONAL ACADEMY OF SCIENCES

THE National Academy of Sciences held its autumn meeting at Princeton, New Jersey, on November 18, 19 and 20.

The academy was welcomed by Dr. John Grier Hibben, president of Princeton University, and response was made by Dr. T. H. Morgan, president of the academy. The following papers were presented:

Aims and opportunities of oceanography: H. B. BIGELOW (introduced by F. R. Lillie).

A classification of stellar systems: H. SHAPLEY.

Radiation of the planet Earth: C. G. ABBOT.

The triangulation system of the United States: WILLIAM BOWIE. The federal government has been for many years executing triangulation in the United States along the coasts and through the interior of the country. There are now 25,600 miles of arcs of triangulation of first-order accuracy. This triangulation has many practical uses and great scientific value. It is the basis for the location of boundaries between the United States and Canada and Mexico, and of the boundaries of states, counties and even of privately owned lands. It is also the basis for the topographic and other surveys of the country and of the maps compiled from those surveys. In the scientific field, triangulation is used in the study of the shape and size of the earth, in tests of isostasy, in the determination of plumb-line deflections and in seismological studies involving horizontal earth movements. In his determination of the velocity of light Dr. Michelson used the distance between Mount Wilson and the San Antonio Peak in southern California, which had been determined with unusual accuracy by triangulation. When the triangulation net of the country is completed, which should be within the next ten years, there will be arcs of first-order work placed at intervals of approximately one hundred miles. This network of first-order triangulation will be supplemented by arcs of second-order triangulation. When the first- and second-order work has been completed there will be no place within the country more than about twenty-five miles from a triangulation station. The stations of triangulation are marked in a substantial manner with inscribed metal tablets placed in outcropping rock or in large blocks of concrete. Reports are published from time to time giving the latitudes and longitudes of the triangulation stations, the lengths and azimuths of the lines and the description of the stations and their monuments.

Remarkable beryls in the Maine pegmatites: W. B. SCOTT. In the Albany Quarry, near Albany in Maine, has lately been uncovered a group of crystals of beryl which are quite unprecedented in the matter of size. These crystals are from twelve to fourteen feet in length and two or three feet in diameter. Two lantern slides, illustrating them from different points of view, are shown. The object in presenting this brief statement to the academy is to ascertain if some way of saving this wonderful group and keeping it *in situ* can not be devised.

On electron diffraction: G. P. THOMPSON.

A chronograph for recording rhythmic processes, together with a study of the accuracy of beat of the turtle's heart: ALFRED L. LOOMIS and E. NEWTON HARVEY. Oscillatory or periodic processes may occur in the inorganic world with the greatest regularity, for example, the swing of a pendulum or the vibration of a tuning-fork or quartz crystal, and are consequently used as a basis for the measurement of time. Graphs of such processes are fundamentally sine curves with a displacement alternately positive and negative to some zero position. Periodic processes are also common in cells and tissues, for example, the beat of the heart, the rhythm of breathing or walking or beating time, ciliary rhythms or the periodic discharge of sense organs or impulses from nerve cells. The frequency may vary from that of breathing to the discharge from nerve cells of over one hundred per second. These rhythms are not oscillatory in character since the displacement is always positive from a zero position, as if a rectifier had been used in an alternating current circuit. They are similar to the "relaxation oscillations" of a neon lamp in parallel with a condenser which is charged through a high resistance to the break-down potential of a neon lamp, when the condenser then discharges through the lamp, and the process is repeated. In fact, Van der Pol has constructed an artificial heart, based on this principle, which imitates the fundamental features of the electrocardiogram. Such examples of periodic processes should more properly be called pulsations. In the case of nerve and muscle tissue the period of pulsation is undoubtedly determined by the rate of some periodic chemical reaction which may be compared to the rhythmic decomposition of H_2O_2 by a Hg surface or the rhythmic solution of metals in acid or alkali. In order to record graphically rates of pulsations over long time periods one of us (A. L. L.) has devised a chronograph which records the time for ten pulsations to occur by the length of a line of ink drawn by a moving pen on a moving sheet of paper. During the next four pulsations the pen is returned to its zero position and is then ready to record the average time for ten more pulsations. Each line therefore represents fourteen pulsations and tells the average time for ten pulsations to occur. The machine is driven by a synchronous motor running on the A.C. lighting circuit. By reducing gears and pulleys the paper is moved at the proper speed, and the pen, attached to a pulley string, is drawn across at a constant rate of ten units per second. The string pulley which draws the pen is actuated by an electromagnetic clutch in connection with a fourteen-toothed wheel and an escapement, also worked magnetically. Each pulsation to be recorded is made to close an electric circuit that magnetizes the electromagnet moving the toothed wheel one tooth. While the wheel revolves ten teeth the magnetic clutch moves the pen at constant speed across the

paper, and during the next four teeth the magnetic clutch is out and a spring pulls the pen back to the first position. If ten pulsations occur in ten seconds the unit lines on the paper (ten to a second) represent a 1 per cent. difference in rate and the paper can be calibrated by recording pulses of current at a rate of one per second. By mere inspection of the paper record one can observe any change in rate and very quickly calculate the percentage accuracy of the rhythmic process. Three types of pulsations have been recorded: (1) relaxation oscillations of a neon lamp; (2) heart beat; (3) voluntary tapping of a key. The flashing of a neon lamp did not vary more than 1 per cent. during a period of four hours. The voluntary rhythm necessary for tapping a key, as was expected, showed a great variation, as much as 20 to 30 per cent. over a period of fifteen minutes. The fundamental heart rhythm, on the other hand, often showed remarkable regularity. For this study the heart of a turtle was excised and mounted in Ringer's solution in a thermostat whose temperature was kept at 25° ± 02° C. The heart is therefore cut off from cardio-inhibitory and accelerator effects. A continuous stream of oxygen bubbles stirred the Ringer and supplied this gas to the auricular muscle which was tied to a heart lever that made and broke a mercury contact, the signal to the chronograph. Because of early difficulties with oxidation of the mercury contact, a vacuum-tube relay was embodied in the chronograph to make certain that the signal came through. The heart was therefore kept under as constant conditions of temperature, O_2 supply and pH as possible and was not touched in any way. There is a great deal of variation in different hearts; one slowed 60 per cent. during a twelve-hour period, while another varied less than 2 per cent. over nearly five hours and less than 1 per cent. over half-hour periods. There are commonly periodic changes in rhythm superposed on the heart beat. A heart may show a 6 per cent. decrease in rate lasting three minutes every twenty minutes for four twenty-minute periods, or similar 3 to 4 per cent. increases in rate lasting a few minutes for three periods fifteen minutes apart. Such rhythmic changes in rate are not connected with the tone changes often observed in the auricles, whose period is forty to fifty seconds, nor can they be traced to any change in the environment. They are true variations of the fundamental rhythm. This chronograph is beautifully adapted to study the effect of drugs on rate of beat. Thus the accelerating action of adrenalin and its reversal if the heart is first treated with ergotamine appear nicely. One part adrenalin to 10^9 parts Ringer will increase the rate an easily detectable amount, about 10 per cent. Adrenalin also prevents tone changes of the auricles and makes the rhythm more regular. One heart in Ringer containing glucose to which $1:10^7$ parts adrenalin was added from time to time gave a continuous record for thirty-six hours at 25° C. before the tissue became white and coagulated and lost its irritability. It is possible to keep the rhythm fairly constant over this long time while the amplitude of the heart muscle contractions continually decrease.

Ether drift experiments in 1929 and other evidences of solar motion: DAYTON C. MILLER. The ether-drift interferometer, previously used on Mount Wilson in California from 1921 to 1928, has been remounted on the campus at Case School of Applied Science, Cleveland. Some minor improvements have been adopted, such as shock-absorbing pads on the supporting piers, to eliminate traffic vibrations, and added precautions have been taken to eliminate temperature disturbances. The methods of making and reducing observations are so devised as to remove the possibility of instrumental or terrestrial disturbances, and the observed effects seem to be cosmic in origin. As before, the interferometer has a sensitiveness represented by a light path of 214 feet, or about 130,000,000 wave-lengths of light. The numerical results are reliable to the hundredth part of a wave-length of light, corresponding to one half of a kilometer per second of relative motion of the earth and the ether. A series of experiments recently completed gives results wholly in accord with those previously obtained at Mount Wilson; the observed effect is such as would be produced by a relative motion of the earth and ether of about ten kilometers per second. The direction of the indicated motion is fixed with relation to sidereal time; that is, it is towards a fixed point in space, as of a motion of the solar system towards the point having a right ascension of seventeen hours, and a declination of 68 degrees north. Ether drift produces an effect as observed in the interferometer which is proportional to the square of the ratio of the velocity of the cosmic motion of the earth and the velocity of light; this is a "second order" effect, and is periodic in each half revolution of the interferometer. The complete theory of this experiment shows that there is necessarily also present a "first order" effect periodic in each full turn of the interferometer; this has never before been taken into account. But it is now shown that this effect is always present and that it is in accord with the theory, and it is considered a further evidence of the validity of the present experimental results. It seems impossible at the present time to account for a cosmic effect of this small magnitude, and it will be necessary to continue these experiments and to coordinate them with others before an acceptable theory can be propounded. It is interesting to note that the present interferometer is mounted about three hundred feet from the location of the original Michelson-Morley interferometer of 1887, and that the magnitude of the observed effect is almost exactly the same as that obtained by them. The recent results, therefore, notwithstanding a prevalent opinion to the contrary, fully agree with and confirm the original Michelson-Morley observations, though the present interpretation is different. Attention is called for the first time to the results of several recent important experiments in diverse fields which seem to corroborate the indicated cosmic motion of the solar system. Meridian circle observations of star places made by direct and reflected rays show peculiarities which are explained by assuming a motion of the solar system towards the sidereal time meridian of about seventeen hours. This effect has been found by the independent observations of Courvoirsier (Berlin) and of Esclangon (director of the Paris Observatory). Esclangon finds evidence of similar motion in observations of lunar occultations of stars,

and still more convincingly in elaborate studies of earth tides (deformation of the earth's crust) and of ocean tides. In the latter work, he considered 166,500 observations, extending over a period of nineteen years. The well-known study of radial and proper motion of stars in our own galaxy by Campbell (Lick Observatory) and by Wilson (Dudley Observatory) give a motion of the solar system towards the constellation Hercules, of eighteen hours right ascension. Stromberg (Mount Wilson Observatory), from an investigation of clusters and nebulae, finds evidence of a motion of the solar system with its apex at twenty-one hours right ascension and declination of 56 degrees north. By a study of the reflection of light, Esclangon finds strong evidence for what he calls an "optical dissymmetry of space" with its axis of symmetry in the meridian of twenty hours sidereal time. This effect would be explained by an ether drift, and the results are in striking agreement with the ether-drift observations here reported. Many recent observations on cosmic rays show a very definite maximum of radiation coming from the direction indicated by the meridian of seventeen hours sidereal time. The very extensive observations of Kolhorster and Von Salis, and Weld and of Steinke, all show this effect. Observations made on the non-magnetic ship *Carnegie* show a maximum at seventeen hours sidereal time for the observations made between 30 degrees north and 30 degrees south latitude. There are several anomalies in astronomical observations of less definite character, which, however, might be explained by the existence of an ether drift. Such anomalies occur in connection with the observed constant of aberration, standard star places and clock corrections determined at different times of day. There are at least twelve different experimental evidences of a cosmic motion of the solar system, all indicating the same general direction, and ten of them show a motion towards a right ascension lying between sixteen and one half hours and eighteen hours. Seven of these investigations give the declination as well as the right ascension, and thus determine the apex of the motion of the solar system. The various apexes all lie within a circle on the celestial sphere having a radius of 20 degrees. This is a remarkable agreement considering the nature of the various observations involved.

The infinitely small in biology and medicine (illustrated with moving pictures): SIMON FLEXNER.

Crystalline pepsin: J. H. NORTHROP (introduced by Simon Flexner).

Spontaneous and induced streptococcus disease: THEOBALD SMITH.

On some race differences in the structure of human spinal nerves (observations of Dr. H. Ide): HENRY H. DONALDSON. The results to be presented are based on observations by Dr. H. Ide, now working under my direction. The outcome has been the determination in man of several structural differences between the corresponding nerves of the white and Negro races. It is with these differences that we are at the moment concerned. Through the very great kindness of Dr. T. Wingate Todd, of Western Reserve University, there were made available for study, segments of the sciatic and the median nerves from twenty-two white males and thirty Negro males. These were taken from the less fortunate population-group in the city of Cleveland. These nerves were cross sectioned and prepared for microscopic study. Using such sections, determinations were made of (1) the total area, (2) the number of fasciculi, (3) the area of the fasciculi, (4) the area of the largest fibers and (5) the differences in these characters according to side (right and left). The results can be shown by the aid of the lantern. Slide 1 gives the outline of two sciatic nerves with an indication of the bundles of fibers or fasciculi in them. The section is composed mainly of supporting tissue that is non-nervous, while imbedded in this tissue are the fasciculi. It may be noted in passing that in the section from the Negro here shown there are 77 fasciculi while in that from the white man there are only 57. We shall return to this point in a moment. In making, between the two races, a comparison of the several characters just mentioned, the mean values for the right and left nerves were those used in each case. These data for the twenty-two whites were divided into four groups of six, five, five and six individuals respectively, and for the thirty Negroes, similarly into four groups of eight, seven, seven and eight individuals. The mean value for each group was found and these were plotted on a base-line for body size. Slide 2 shows the area of the entire nerve. Sciatic above; median below. In both the nerves the areas for the Negro (heavy line) run above. The difference in the case of the sciatic (4 per cent.) is hardly significant, but in the median the difference is 16 per cent. Passing to the number of fasciculi a distinct difference according to race appears. The Negro has 31 per cent. more fasciculi in the sciatic and 54 per cent. more in the median. A graph shows the combined areas of the fasciculi. In both nerves the Negroes have the greater area by 19 per cent. in the sciatic and 9 per cent. in the median. In each section the areas for a definite number of the largest nerve fibers were determined. These areas are greater in the Negro by 20 per cent. in the sciatic and 20 per cent. in the median. These larger fibers in the Negro are undoubtedly related to the larger area of the fasciculi shown in the previous slide. Finally, if the deviations in the foregoing values are determined according to side it is found that while in the white males the nerves of the right side show greater values, 9 per cent. on the average, the corresponding right and left values tend, in the Negro, to be more nearly alike, the measurements showing only 3 per cent. excess on the right. In support of these observations it may be added that a series of nerves from thirteen white females show relations as to side similar to those in the white males. From the study of the material now available it is concluded that in the case of the sciatic and median nerves of man, the Negro males, as compared with white males, show: larger nerves; more fasciculi; a greater area of the fasciculi; a greater area for the largest nerve fibers, and approximate equality in these characteristics on the right and left sides. We may infer that what *is true for*