ents who want children should in most cases be helped to have them" then the career-seeking and the prosperous, the ambitious and educated would have even fewer children and the group at the opposite socio-economic scale would have more of them. A feeble-minded girl discharged from a state institution had 14 children, perhaps because she wanted them.

As a whole, the book is well and interestingly written. The principal criticism might be that the author tends to make generalizations which are the result of his profound conviction and reasoning, but for which the factual basis is often not given. Of the high idealism of the author there can be no doubt, but as to whether we should wait for the completion of the preface before beginning education in regard to mate selection and inheritance of traits there may well be a difference of opinion, and to many students the preface to the Preface would be more research.

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THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS

(*Continued from page 458*)

Orthogonal polynomials and closure: JAMES A. SHOHAT (introduced by L. P. Eisenhart). The following two results are established: (1) If closure holds for a symmetric system of orthogonal polynomials (OP), it also holds for property related non-symmetric systems of OP, and *vice versa*. Illustration: the polynomials of Hermite and Laguerre. (2) If the remainder in Parseval Formula, applied to a given $f(x)$, is $O\left(\frac{1}{\log^{2+\epsilon} n}\right)$, with some $\epsilon > 0$, then the expansion of $f(x)$ in a series of OP under discussion converges almost everywhere in the orthogonality interval (a, b), assumed to be finite. This yields very general criteria of convergence, in particular, for continuous functions.

General invariants of irregular curves: EDWARD KASNER. The general group of analytic transformations is applied to curves expressed in fractional power series. Some types have invariants, some have not. This presents a new aspect of restricted topology. An extensive complete classification has been obtained with the collaboration of J. De Cicco.

A supplement to Ramanujan's identities: HANS RADEMACHER (introduced by L. P. Eisenhart). S. Ramanujan gave two identities which make evident certain divisibility properties of the number of partitions $p(n)$. If these identities are written in terms of the Dedekind function $\eta(\tau)$ they can be subjected to modular transformations. In this way we obtain new identities, which are noteworthy because of the occurrence of the Legendre symbol.

The evolution of a peculiar stellar spectrum: Z Andromedae: OTTO STRUVE and P. SWINGS. The new 82-inch telescope of the McDonald Observatory has been devoted, during the past year, to a study of a relatively small group of peculiar stars whose spectra can not be fitted into the continuous sequence of normal stellar spectra. One of the most remarkable members of this group is the variable star, Z Andromedae. It was discovered as an irregular star of variable brightness in 1901 and it was early suspected to be subject to eruptions similar to those of a nova. The latest eruption took place a year ago, with an increase in brightness from magnitude 10.7 to magnitude 7.9. Since then the brightness has slowly declined. This eruption was accompanied by changes in the spectrum. Near maximum light the spectrum was that of a P-Cygni type star showing lines of relatively low excitation (Fe II, Ti II, etc.), displaced toward the violet by amounts corresponding to velocities of expansion between 100 and 60 km/sec. Since the early summer of this year the spectrum has taken on an entirely different character. We recognize essentially four distinct sources of light: (*a*) a hot star presenting some of the characteristic features of Wolf-Rayet stars; (*b*) a cool, M-type, giant star forming a binary system with the hot star; (*c*) a tenuous nebula giving rise to forbidden and permitted emission lines of [O III], O III, [Ne III], [Ne V]; this nebula probably surrounds the binary system; (*d*) remnants of an expanding shell giving rise to a P-Cygni type spectrum of H, He I, Fe II and to emission lines of Mg II, Si I, Si II, Ti II, Fe I and [Fe II]. The occurrence of irregular violent outbursts in a binary system is of special interest. They are probably responsible for the enveloping nebula and for the disappearing spectrum of the expanding shell. The latter is remarkable because of the exceptional strength of the so-called forbidden auroral transition of [O III] at λ 4363. This line is also strong in several other binary systems of similar type, namely, in T Coronae, AX Persei, CI Cygni, RW Hydrae, etc. The effect is interpreted as a consequence of high electron density in the nebula—a phenomenon which we have also observed in the planetary nebula IC 4997. Z Andromeda bears a certain resemblance to the famous variable Mira Ceti, in which the hot binary companion is a variable emission-line star of spectral class B, and to Antares, whose hot companion is surrounded by a small nebulosity which exhibits forbidden lines of [Fe II]. It is exceedingly probable that the close association of a cool giant star with a compact, hot companion results in disturbances which we observe as eruptions, and which produce a succession of spectroscopic anomalies: an outburst of the surface layers of one of the two components, the gradual dissipation of the exploded material and, finally, the creation of a nebula surrounding the entire system.

Orbital motion in the multiple system Sigma Coronae Borealis: PETER VAN DE KAMP and JANET M. DEVILBISS (introduced by C. E. McClung). A twelfth magnitude

star sharing the proper motion of the well-known visual binary Sigma Coronae Borealis was discovered a year ago on plates taken with the twenty-four-inch refractor of the Sproul Observatory. The positions of the distant companion (c) and of the two components of the classical pair (A,B) were measured on 29 plates taken on 22 nights since 1916. The resulting relative motions were reduced to a reference frame of thirty-five faint stars. The relative proper motion of the faint companion c with respect to the center of a mass of A and B amounts to $+.''0004 \pm .''0023$ in right ascension and $+.''0101 \pm .''0023$ in declination; the errors include the accidental errors of observation and of the inertial system. Compared with the total motion ($0.''29$) of the system A,B the relative motion of c and AB is small enough to leave little doubt about the physical connection of c with AB. Interpreted as orbital motion, it is direct (counterclock wise), as is the relative motion of B and A. The separation of c from the center of mass of A or B is $632.''74$ in position angle 241°6′48″ (2000 equator). The yearly increase in position angle is $2.''8$; the direction of the relative motion differs 59° from the radius vector, which at present appears to be decreasing. With a parallax of $.''048$ (distance 68 light years) the projected linear separation is 13,000 astronomical units. In Sigma Coronae Borealis one thus finds a *quadruple* system, representing the widely different periods of eight days for the spectroscopic system A, about 1,200 years for the visual system A,B, and a period of the order of a million years for the motion of c around AB.

Some galactic explorations in the southern hemisphere: HARLOW SHAPLEY. The metagalactic survey of the southern sky, which is being carried on with the aid of the staff and various telescopes of the southern station of the Harvard Observatory at Bloemfontein, in the Orange Free State, has brought to light many interesting or peculiar objects not heretofore known. Among the items discussed are the following. (1) A new Magellanic Cloud in Phoenix, only twenty degrees from the South Galactic Pole, which is probably of dwarf galaxy type, at a distance of not less than a million light years. (2) Further exploration of the wing to the Small Magellanic Cloud that points in the direction of the Large Cloud and helps to establish the hypothesis that the Large and Small Clouds are a true double system. (3) A new globular cluster that possibly lies between our Galaxy and other members of the local group of galaxies. (4) A region in high galactic latitude that is devoid of faint variables and which indicates therefore the irregularities in the structure of the star haze surroundng our galactic system. (5) A peculiar streak nebula in the southern Milky Way that is somewhat similar to the well-known Veil Nebula in Cygnus. Not heretofore recorded, it is now found on several long-exposure plates, some of which show that its irregular arc is more than four degrees in length, and only about one thirtieth of a degree wide.

Quantum many-body problem: L. I. SCHIFF (introduced by D. W. Bronk). A method is developed to treat the quantum mechanical many-body problem at temperatures so low that degeneracy plays a dominant role. The inter-particle forces are taken into account in a manner analogous to the expension in virial coefficients of the equation of state of a non-ideal classical gas, while the degeneracy is always considered exactly. Thus the first term in the expansion gives an ideal Fermi-Dirac or Bose-Einstein gas, as the case may be, and not an ideal classical gas. The second term gives the correction due to two body encounters; it can be reduced to a set of quadratures if the wave-functions that describe the collisions of two particles are known. The method is now being applied to the phase transition in liquid helium, with the object of finding the nature of the deviations from London's free-particle model. It may also be useful in the theory of metals and of atomic nuclei.

A pragmatic approach to the elementary principles of wave mechanics: WILLIAM F. G. SWANN (introduced by D. W. Bronk). The paper proceeds by a route which does not involve, and has meaning apart from, the concept of charged particles. The starting concept is that of a state of a system, supposed defined by a function ψ of a number of variables, which for purposes of illustration is taken as 3. Two kinds of states are involved. We have states such as those of the hydrogen atom where there is nothing to be seen as associated with the state itself, and where the story of interest is in the transitions. Then we have states represented by what, in the ordinary descriptions of phenomena, correspond to such things as beams of electrons deflected in cathode ray oscillographs, but which in actuality present for observation beams of luminescence whose boundaries are to be associated with the boundaries between regions where ψ is zero and regions where it is finite. It becomes recognized that the shapes of such observable characteristics of a state can be described by a principle of least time, with a suitable chosen velocity μ, varying from point to point in such manner as to be proportional everywhere to $1/(E-V)^{1/2}$, where E is the potential difference which creates the beam, and V is the potential at a point between plates which deflect it, both being measured by voltmeters, for example. A recognition of the fact that a beam such as the foregoing can—in what are called electron diffraction experiments—become split into several beams suggests laws of interference such as demand periodic phenomena, and implies that the beams themselves are ray paths in a wave system governed by the velocity μ aforesaid. The ordinary diffraction experiments are usually regarded as establishing the law $\lambda = h/mv$, but confinement of attention to what is *observed* experimentally leads merely to a relation, $D \sin\theta = sg/E^{1/2}$, where s is an integer, D is the grating space, θ is an angle of deflection appropriate to the experiment, and E is the voltmeter potential difference which created the beam. The essential gift of experiment is to reveal the constancy of $E^{1/2} \sin\theta$ and so through the association of $D \sin\theta$ for $s=1$ with the wave-length λ, that quantity becomes determined as $g/E^{1/2}$ and the velocity μ for this case of zero V becomes determined in terms of the frequency ν as $\mu = g\nu/E^{1/2}$. Association of this result with the proportionality between μ and $1/(E-V)^{1/2}$ for the case where V is not zero leads to $\mu = g\nu/(E-V)^{1/2}$. With this μ

we write down a wave equation, and solving it for periodic solutions, we arrive at a Schroedinger equation from which ν has disappeared explicitly, and only the experimentally determined constant g remains. The equation then gives eigen-values proportional to $1/n^2$, where n is an integer, provided that V is taken of the form q/r, where q is any constant. If we associate the eigen-values with the excitation potentials W_n for hydrogen, we can determine the numerical value of q. Subsequent association with line spectra for hydrogen through the relation $\nu_{mn} = A(W_m - W_n)$ determines a new constant A, or, if we choose, a quantity h, defined by q/A. The electronic mass, m, makes no appearance at any point in a non-relativistic formulation.

Experimental studies on the physiology of diving mammals: LAURENCE IRVING, P. F. SCHOLANDER and S. W. GRINNELL (introduced by M. H. Jacobs). Seals (*Phoca vitulina*), porpoises (*Tursiops truncatus*) and Florida manatee have been observed during experimental dives of 15, 3 and 15 minutes, respectively. Characteristics of external respiration were recorded on a respirometer showing ventilation, O_2 consumption and difference between CO_2 and O_2 exchange as a basis for examining the sequence of physiological adjustments in detail. The heart rate of seals decreases immediately after a dive to about 10 per cent. of its normal frequency and returns at once on emergence. The bradycardia in porpoises and manatee is not less than half normal. In the arterial blood O_2 is steadily depleted during a dive and exhaustion of O_2 marks the limit of a diving period. Lactic acid does not increase in the blood to any extent during the dive, but in the recovery period lactic acid floods the blood of seals and manatee, and its CO_2 content diminishes in proportion. Surprisingly little lactic acid was formed in porpoises. Periodic analyses of muscles during dive and recovery showed that the oxygen content, about 5 volumes per cent. before the dive, is almost completely reduced in five minutes, and is restored quickly in recovery. Lactic acid apparently increases little until the time when the myoglobin is reduced and then rises more rapidly to a maximum as great as 300 mg per cent. at the end. CO_2 content does not change in the dive, but diminishes after recovery starts, when lactic acid is still high in the muscles and is appearing in large quantities in the arterial blood. The abdominal temperature remains constant during a dive, but the muscle temperature decreases. In recovery the abdominal temperature drops. The temperature changes indicate diminished provision of heat to the peripheral muscles. Blood flow in the muscles, as indicated by an electrically heated resistance wire type of meter, diminishes promptly in the dive and recovers immediately after. Indications are for sustained flow through the brain. The combined observations fit a scheme of adjustment to diving in which blood flow decreases through the muscles, which are maintained at first by utilizing their intrinsic oxygen reserves, followed by resort to anaerobic formation of lactic acid. The small part of the circulation which is still maintained during the dive provides prolonged aerobic metabolism for a selected part of the tissues, and when the oxygen available from blood is expended the diving capacity is at an end.

Collection and analysis of fluid from single glomeruli and tubules of the mammalian kidney: ARTHUR M. WALKER and JEAN R. OLIVER (introduced by A. N. Richards). This investigation represents an extension to the mammalian kidney of the type of experimentation employed by Richards and his collaborators on the amphibian kidney. Certain technical difficulties having been overcome, it became possible to visualize tubules and glomeruli upon the surface of eviscerated anesthetized guinea pigs and opossums, to cannulate these units with a quartz pipette, and to collect sufficient fluid from them for quantitative analysis of protein, glucose and total molecular concentrations by ultramicro methods. The portion of the tubule from which fluid was collected was precisely identified by the maceration technique of Oliver. A series of thirty experiments has been completed. The results prove that glomerular fluid has the same glucose and total molecular concentrations as blood plasma and usually contains no protein, that glucose is reabsorbed by the proximal tubule, and that the total molecular concentration of tubule fluid does not rise until the proximal segment has been passed. These results are analogous to the localization of function which has been demonstrated in amphibia.

Relative overgrowth of the central nervous system in vitamin A deficiency in young animals: S. B. WOLBACH and OTTO BESSEY. Vitamin A deficiency in young animals (rats, guinea pigs, dogs) if established early, during the period of greatest growth rate, has as one of its striking consequences injury to the nervous system involving sensory and motor functions. The explanation has been found to be overgrowth of the central nervous system in relation to its bony enclosure, resulting in mechanical damage to brain, spinal cord and nerve roots. Our studies have been made chiefly upon white rats. In this animal the gross manifestations of the growth differential established by the deficiency are: (1) overcrowding of the cranial cavity with distortion of the brain, shown by dislocation toward the foramen magnum and extrusion of the cerebellum and cerebrum into the venous sinuses of the dura at the sites of arachnoidal villi; (2) overcrowding of the spinal canal with distortion of the caudal end of the spinal cord and herniation of nerve roots into the intervertebral foramina and into the bodies of vertebrae; (3) resorption of bone of the cranium and bodies of the vertebrae due to pressure. In the latter location deep pits, symmetrically situated and occupied by coiled nerve roots, are formed. In rats the unequal growth of bone and nervous system occurs between the fortieth and sixtieth days of age, a period in the deficiency when weight increase has been but little retarded. If vitamin A (in the form of carotene) is added to the diet at 42 days of age and the diet restricted in amount so that the growth parallels litter-mates in continued vitamin A deficiency, none of the effects described above takes place. On postmortem examination at sixty-three days of age, the rats given carotene show no, or very slight, ana-

tomical changes in the central nervous system, in contrast to the striking lesions found in the litter-mates maintained on the deficiency for the entire period. Growth of bone eventually ceases in vitamin A deficiency and this fact must enter into the explanation of the effect described. However, the study of rats whose growth has been retarded at an equal rate and degree—(1) through inadequate diet with full vitamin complement and (2) through riboflavin deficiency—showed normal relations of nervous system to skeleton. Guinea pigs in general responded to the deficiency, as did rats. One experiment with dogs indicates that the maximum effect in this animal will be found in cranio-cerebral relations. We are unable to explain satisfactorily this disproportionate growth established in young animals by vitamin A deficiency. In order to evaluate data on hand, a more complete knowledge of the growth sequences of the skeleton of the rat must be obtained. We are convinced that vitamin A deficiency does not retard the growth of the nervous system. Our studies thus far suggest that the most important consequence of vitamin A deficiency upon growth of the skeleton is upon those sequences concerned in the substitution of bone for cartilage—*i.e.*, endochondral growth of bone. Unretarded growth of the central nervous system and disturbances in initiation and development of centers of ossification are the two obvious factors to be considered in the search for an explanation of the effects we have described. These two factors, when considered in relation to normal growth sequences and anatomical differences of the several species exhibiting lesions of the central nervous system in consequence of A deficiency, may possibly explain the different effects thus far described in rats, dogs and calves.

(To be concluded)

REPORTS

THE NATIONAL DEFENSE RESEARCH COMMITTEE

DR. VANNEVAR BUSH, chairman of the National Defense Research Committee, has made public a list of scientific men and engineers who have thus far accepted definite appointments to work with the committee. The committee will deal with particular problems as they arise. Further appointments will be made as rapidly as effective use can be made of additional individuals in the solution of specific problems.

Created by order of the Council of National Defense on June 27, the National Defense Research Committee consists of the following eight members:

Vannevar Bush, *Chairman*, president, Carnegie Institution of Washington.
Richard C. Tolman, *Vice-Chairman*, dean of the Graduate School, California Institute of Technology.
H. G. Bowen, Rear Admiral.
Conway P. Coe, Commissioner of Patents.
Karl T. Compton, president, Massachusetts Institute of Technology.
James B. Conant, president, Harvard University.
Frank B. Jewett, president, National Academy of Sciences; chairman of the Board of Bell Telephone Laboratories.
G. V. Strong, Brigadier General.

The secretary of the committee is Dr. Irvin Stewart, director of the Committee on Scientific Aids to Learning.

Dr. Bush, as chairman, is coordinating the work of the committee with that of other governmental and private agencies and is maintaining direct supervision over a limited number of problems. General Strong and Admiral Bowen are responsible for the maintenance of close working relationships between the committee and the military services. Commissioner Coe is in charge of matters relating to inventions and patents and provides a direct connection between the committee and the National Inventors Council.

Dr. Tolman is chairman of the division dealing with armor and ordnance, Dr. Conant of the division dealing with chemical problems, Dr. Jewett of the division dealing with communication and transportation, and Dr. Compton is in charge of the work on detection, controls and instruments.

Professor Charles C. Lauritsen, of the California Institute of Technology, is vice-chairman of the division concerned with armor and ordnance. Those who have already accepted appointments to work on problems with which that division deals include:

P. H. Abelson, Carnegie Institution of Washington.
Samuel K. Allison, University of Chicago.
Ralph D. Bennett, the Massachusetts Institute of Technology.
Robert A. Becker, California Institute of Technology.
L. V. Berkner, Carnegie Institution of Washington.
Walker Bleakney, Princeton University.
John E. Burchard, the Massachusetts Institute of Technology.
Donald S. Clark, California Institute of Technology.
R. H. Crane, University of Michigan.
J. A. Fleming, Carnegie Institution of Washington.
Wm. A. Fowler, California Institute of Technology.
Ralph E. Gibson, Carnegie Institution of Washington.
R. H. Goddard, Clark University.
George Kenneth Green, Carnegie Institution of Washington.
L. R. Hafstad, Carnegie Institution of Washington.
C. N. Hickman, Bell Telephone Laboratories.
J. C. Hubbard, the Johns Hopkins University.
Emory Lakatos, Bell Telephone Laboratories.
R. C. Meyer, Carnegie Institution of Washington.
R. B. Roberts, Carnegie Institution of Washington.
H. P. Robertson, Princeton University.