would seem that the relatively higher lignin content makes the straw (or wood) brittle so that it tends to break under the violent impact of winds, whereas with a normal lignin content the plants only bend and straighten out again.

No explanation can be offered at present for the increase in lignin caused by nitrogenous hypernutrition. It may be due to an effort on the part of the plant to overcome the weakening of the culms caused by the relative decrease in silica.

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Salts of the enolic form of quinaldine: F. W. BERGSTROM (introduced by E. C. Franklin). Formally quinaldine is a ketone of the ammonia system because of the CH_3–C=N– grouping, but the ketonic properties are generally subordinated to the stability of the six-membered ring. Nevertheless quinaldine reacts readily with liquid ammonia solutions of the ammono bases, KNH_2, $NaNH_2$, $LiNH_2$ and $Ba(NH_2)_2$ to form salts. These salts are colored a deep red and are very reactive. A liquid ammonia solution of ammonium bromide reacts with them to form an unstable ammonium salt, or perhaps the pseudo quinaldine itself, which soon changes into ordinary quinaldine. Methyl iodide and ethyl bromide, in liquid ammonia solution, react to form, respectively, 2-ethyl and 2-n-propyl quinoline, a reaction akin to the alkylation of acetoacetic ester. The potassium salt of the enol modification of quinaldine is readily soluble in ether. The above-mentioned reactions can also be carried out in ether solution.

The rotation of the planets Uranus and Neptune determined from spectroscopic observations (illustrated): J. H. MOORE (introduced by R. G. Aitken). In 1911 Lowell and Slipher found from their spectrographic observations of Uranus that the planet is rotating in the same direction as that of the revolution of its satellites and with a period of 10¾ hours. Leon Campbell, Slavenas and others have reported a variation in the planet's light in very closely this period, while Stebbins, from observations made with the photoelectric photometer, concluded that the light of Uranus is constant. Recent observations obtained at the Lick Observatory with spectrographs of three-prism and one-prism dispersion confirm the direction of the planet's rotation as found by the Lowell observers. The period of rotation derived from fifteen one-prism spectrograms in 1928, 1929 and 1930 is of the order of that previously found. The three-prism spectrograms to which exposures of 6 hours were given are under exposed and difficult to measure. The period derived from two of these obtained in 1927 is 11.5 hours. A consideration of the probable sources of the discrepancy in observations of planetary rotation obtained with different spectrographs shows that for objects like Uranus and Neptune with small apparent disks the rotation period determined spectrographically is at best only approximate. Seven well-exposed spectrograms of Neptune were obtained with the one-prism spectrograph in 1928. The slit was placed parallel to the planet's equator, the position of which was derived by Eichelberger and Newton on the assumption that the well-known motion of the plane of the satellite's orbit is caused by the attraction of an equatorial protuberance on the planet. All these spectrograms show a very noticeable inclination of the spectrum lines, in the sense that the portion of the line originating at the east limb of the planet is displaced toward the violet, indicating that the rotation of Neptune, like the other planets, with the exception of Uranus, is direct. The measured inclination of the lines yields an approximate period of rotation for Neptune of 15.8 ± 1.0 hours. The investigation of the rotation of Uranus and Neptune was carried on jointly by the author and Dr. D. H. Menzel.

Spectrophotometric measures of interstellar light-absorption (illustrated): ROBERT J. TRUMPLER (introduced by R. G. Aitken). The investigation of open star clusters recently furnished some definite evidence that within our Milky Way system light rays, passing through interstellar space, suffer a loss of intensity. Such a phenomenon is usually designated as "absorption" in the most general sense of the word. On the one hand the evidence is based on the fact that distances of open star clusters derived from their angular diameters do not agree with those derived from magnitudes and spectral types of the stars. On the other hand, we also find a change of color with distance for stars of the same spectral type, which indicates that the absorption is selective, *i.e.*, that it depends on the wave-length of the light. In order to gain information on the physical process causing this absorption and on the nature of the absorbing medium, it is of prime importance to find the law according to which the absorption depends on the wave-length. For this purpose the spectra of the brighter stars in the clusters N.G.C. 6910 and N.G.C. 6913 (distance about 2,000 parsecs) were observed with the slitless quartz spectrograph of the Crossley Reflector and compared with the spectra of relatively near stars of the same spectral type. Taken on Panchromatic plates these spectra cover the region from 6300 A to 3200 A and show at once the great difference in the intensity distribution of the continuous spectrum between near and distant stars. This difference, which must be an effect of interstellar light absorption, was measured with a Moll self-registering microphotometer. The results show that the absorption increases rapidly with decreasing wave-length; but the absorption does not seem to be inversely proportional to the fourth power of the wave-length, which law should hold if the effect were due to Rayleigh scattering by extremely small particles.

Report on the completion of the research surveys of 1,091 minor planets: A. O. LEUSCHNER and H. THIELE.

The conclusion of the research surveys of 1,091 definitely known minor planets and partial revision of the manuscripts for publication was announced by the authors, who have been engaged on this work under the auspices of the National Research Council with the assistance of Mrs. Maud W. Makemson as chief assistant. The purpose of this work is to lay a foundation for future research on the motions of the minor planets by collecting in systematic form all the permanent results of the investigations made by astronomers on this subject since the discovery of the first minor planet at the beginning of the last century. Only material of fundamental value has been included in the research surveys, and results of temporary significance based on approximate methods have been eliminated. The research surveys are expected to form the beginning of a new era in the treatment of the motions of minor planets. It should now be possible to attempt a more precise valuation of the various methods of perturbations which have been applied in prediction and of the effectiveness of the programs of research followed at various national institutes for the determination of the motions of the minor planets.

Tables from the year 1930 to 2020 of the perturbations by Jupiter of twelve minor planets discovered by James C. Watson: A. O. LEUSCHNER and H. THIELE. In 1910 the senior author published investigations begun in 1901 under the auspices of the National Academy of Sciences by himself, with the assistance mainly of Professor R. T. Crawford and Astronomer F. E. Ross, of the perturbations by Jupiter of twelve of the minor planets discovered by James C. Watson. At that time it was hoped that the results might remain valid until about the year 1930, when, according to past experience, a revision of the extensive calculations was expected to become necessary. However, the departures of the planets concerned, as determined for the eleven years from 1918 to 1929, have been found immaterial for all practical purposes, so that the predictions based on the Berkeley calculations are now certain to hold for many decades to come, without revision. Under a grant from the Watson Fund the tables of perturbations of these twelve minor planets have been carried forward, from the original developments, from the year 1930 to 2020.

Aztatlan: prehistoric Mexican frontier on the Pacific coast: C. O. SAUER (introduced by A. L. Kroeber). In the course of field studies in 1930 numerous and extensive unreported prehistoric ruins were observed in the southern half of the state of Sinaloa and in northern Nayarit. Thirty-two sites were visited, all of which belong to one culture province. The largest ones and the most numerous are located in the great flood-plains, or on their margins. Others occur in residual basins of Piedmont position. Still others are found in the barranca country of the highlands and on coastal lagoons. The artefacts indicate that this region was a part of the Central Mexican culture complex. Archaic elements are present in many terra-cotta figurines, which were noted most abundantly in the small upland sites. The large valley sites are of such mass and thickness of residuum as to indicate long occupation. The major part of the culture debris appears to belong to the great Toltec period. Polychrome pottery, elaborately engraved ware, obsidian knives, decorated spindle whorls and patterned cylinders are of greatest interest. In the flood-plain settlements mound building was practiced, which southward is developed into earth pyramids, apparently of sacrificial character. The culture area appears to cut off sharply north of the Culiacan Valley, though there are no physical obstacles to its expansion in that direction. No evidence was found of connection northward along the west coast with the presumably contemporaneous Pueblo culture. Two cultural sub-regions are recognized. The agricultural economy shows no dependence on irrigation. There is the suggestion that the older agriculture began on the drier lands. Everywhere it was based directly on rainfall or flooding. Present agriculture may be illustrative of prehistoric conditions. The development of agriculture in Middle America without irrigation, contrary to current assumption, is considered in the light of present practices and inferences drawn from the archeologic remains. The sites continued to be occupied into historic time as is shown by finds and also is inferred because their character and in part their position integrate very well with Spanish descriptions at the time of the conquest. The field finds confirm the Spanish accounts of extraordinary density and high culture of the native population. The existence of organized markets and of metal mining is established historically. From historical evidence the domestication of fowls other than turkeys is indicated. The fall of this culture is attributed entirely to historic causes. There is a doubtful persistence to the present of house forms, communities and linguistic elements.

Observations on the nature of the process by which mineral elements are accumulated by plant cells: D. R. HOAGLAND (introduced by T. Wayland Vaughan). Experiments carried on during recent years by several investigators prove that it is possible for plant cells to absorb various chemical elements against concentration gradients. Some experiments have been concerned with the fresh-water alga *Nitella clavata,* which produces cells large enough to be manipulated as separate units. The cell sap (containing very little organic matter) has an electrolyte concentration many times greater than that of the solution bathing the cells. Accumulation of certain ions (for example, bromine) against concentration gradients has been studied experimentally. This process has a high temperature coefficient and is dependent to a large degree on the illumination of the plant cells during the period of accumulation or on the after-effect of illumination. Unpublished data obtained more recently by F. C. Steward, using potato tissues, show that analogous accumulation of potassium and bromine may also occur in this case. However, the accumulation by potato tissue (containing stored carbohydrates) was shown to be dependent on the maintenance of proper conditions for oxidation, *i.e.,* passage of a stream of air or oxygen.

Other experiments now in progress on excised barley roots give indication that accumulation requires a supply of oxygen and that the nature and extent of accumulation is modified in accordance with the metabolic conditions existing before excision of the roots. All the present data point to accumulation as a process involving cell metabolism and energy exchanges.

On the question of the uniformity of distribution of cosmic radiations: R. A. MILLIKAN. A new series of experiments of greater sensitivity than any the author has heretofore made has been carried out and new limits have been set to the possibility of an effect of direction and of latitude on the intensity of cosmic radiations. If there is any directional effect at all it can not amount to more than 1 per cent. at the most.

Remark on the nature of cosmic rays: P. S. EPSTEIN.

Application of the Geiger-Müller Ion-counter to the study of the space-distribution of X-ray electrons: E. C. WATSON and J. A. VAN DEN AKKER (introduced by R. A. Millikan). Investigations by Van den Akker have shown that with proper precautions the new tube counters can be used for the *quantitative* study of the intensities of weak electron beams. When used in the magnetic spectrograph to replace the photographic plate they offer the following advantages: (1) greater sensitivity, (2) greater resolving power, (3) a quantitative measure of intensity. Results of a detailed study of the space-distribution of the photoelectrons ejected by molybdenum characteristic X-rays from thin films of gold will be given and comparisons made with similar results obtained photographically.

A method of calculating spectroscopic terms in shells of equivalent electrons: W. V. HOUSTON (introduced by Robert A. Millikan). For a shell of equivalent electrons one can simplify the variational method suggested by Eckart. To each electron is assigned a hydrogen function containing a screening constant as a parameter, but for the shell of equivalent electrons all the screening constants may be taken to be the same. This parameter can then be determined by the variational method. If one term due to an electron configuration is known, all the electrons except those in the outer shell may be considered as merely screening the nucleus, and the amount of this screening can be determined from the known term. The other terms due to the same configuration can then be predicted from the theoretically determined parameters. These parameters also serve to give an estimate of the spin multiplet separations.

The spectrum of carbon in the extreme ultra-violet: I. S. BOWEN (introduced by R. A. Millikan). The spectrum of carbon in the extreme ultra-violet has been studied with the aid of a vacuum spark between very pure graphite electrodes. The lines, thus obtained, have been used to extend the analysis of the structure of the carbon atom in various stages of ionization.

A study of scattered X-radiation and electron momenta with the multicrystal spectrograph: JESSE W. M. DUMOND and HARRY A. KIRKPATRICK (introduced by R. A. Millikan). A description is given of the multicrystal spectrograph, an instrument consisting of fifty small units, each a Seemann spectrograph in itself, cooperating to focus all their spectra in accurate superposition so as to form a single photographic spectrogram. This instrument is now being used in the study of X-radiation (MoKα) scattered from graphite at various scattering angles. It permits of obtaining spectra of scattered radiation under far purer conditions of resolution and homogeneity of scattering angle with much great contrast (freedom from background) than have ever before been obtained without demanding exposures of unreasonable durations. According to a theory of DuMond's (*Phys. Rev.*, p. 643, May, 1929) the natural breadth and structure of the Compton shifted line is attributed to the velocities—or more accurately to the momenta—of the electrons in the solid body that scatters the radiation. On the assumption that conservation of momentum and energy holds for single processes of scattering of X-radiation by electrons it was shown that the Compton shifted line should be broadened in a way similar to the Doppler broadening of spectral lines emitted by moving atoms. A relation was developed between Compton line structure and the statistical distribution of electron momenta so that given either the other could be derived. In particular it was shown that the spectral breadth $\Delta\lambda$ of the Compton line should increase along with the shift as the scattering angle increases, and the exact functional dependence was predicted. Experimental proof of the existence of such a dependence of Compton line breadth on scattering angle has now been obtained with the multicrystal spectrograph and is presented in this paper. The evidence, therefore, for the correctness of DuMond's assumption that the structure of the Compton line is related to the distribution of electron momenta in the scatterer seems very strong, since no other explanation of the predicted and observed functional relations between breadth, shift and scattering angle is at present available. The line structures observed in metallic scatterers constitute confirmatory experimental evidence for the degenerate conduction electron gas of Fermi and Sommerfeld, and invalidate the applicability of the Maxwell-Boltzmann statistics to conduction or "free" electrons in metals.

Artificial gamma rays produced in a 600,000-volt electron tube: C. C. LAURITSEN (introduced by R. A. Millikan). A spectrograph of the Seemann type has been constructed for the purpose of investigating the radiation from the high potential X-ray tube at the California Institute. A typical spectrogram obtained with 600 kilovolts on the tube is presented. The photometer record shows a continuous spectrum with its maximum intensity at about 200 kilovolts and a short wave-length limit in the neighborhood of 600 kilovolts. The range covered is roughly from 100 to 20 x-units. It is proposed to use the apparatus for determining absorption coefficients by photographing the spectrum of radiation which has passed through an absorbing screen. No anomalies of any kind have been observed so far.

Critical elements in study of early man in southwestern United States: JOHN C. MERRIAM. The most ancient occurrences of human remains in southwestern United States present a problem of exceptional interest by reason of the fact that the record of associated life and the details of geological history are relatively more abundant than in many of the regions of the United States where effort has been made to work out the early history of man on this continent. Frequent crustal movements in the region of the Southwest have produced extensive and deep erosion, together with wide-spread and thick accumulation of deposits. In some localities the volume of material thus accumulated, the number of strata represented in the record and the multiplicity of geological incidents arranged in sequence present a background against which projection of the record of life becomes unusually interesting. The extent to which changes in the fauna and migration of life among regions of the Southwest shows relatively large number of changes is yet to be determined by working out of details in both geological and paleontological history. There is some reason for belief that the paleontological history will show a contribution comparable to that of the geological story of the Southwest. With the background of geological and paleontological data presented it becomes of exceptional importance to make intensive study of all remains of man found in the West and especially in the southwestern area of the United States. In connection with previous studies heavy emphasis has been placed on determination whether strata in which human remains have been found are of Pleistocene or Recent epochs. For the moment it is important to learn what the historical sequence is regardless of whether the remains happen to be Pleistocene, Late Pleistocene or Recent. Once the paleontological or archeological sequences are established it will be easier to determine the correlation with stages of the Recent or Pleistocene which have been accepted as standards.

Problems of antiquity presented in Gypsum Cave, Nevada: CHESTER STOCK (introduced by F. L. Ransome). Excavations conducted by the California Institute in cooperation with the Southwest Museum in Gypsum Cave, near Las Vegas, Nevada, reveal the presence of several mammalian types, including the extinct ground sloth (*Nothrotherium*), horse (*Equus*), mountain sheep (*Ovis*), and camel (*Tanupolama?*). The better preserved remains are found in a deposit consisting in large part of sloth dung. The most striking feature of the mammalian occurrence is the unusual preservation of the ground-sloth material. The collection includes in addition to the dung the horny sheaths of claws, hair, small pieces of skin, bits of dried flesh adhering to bones, as well as skull and skeletal elements. Artifacts have been found also in the deposits. The presence of remarkably well-preserved animal remains and cultural objects leads to a consideration of two questions of major importance in the history of Quaternary life in America: (1) Was man coexistent with some or all of the animal types recorded in the deposits? (2) What degree of antiquity in Quaternary time can be ascribed to the mammalian fauna and more particularly to those types found in the dung layer? The occurrence at Gypsum Cave resembles in several respects that recorded some thirty years ago in Eberhardt Cavern, Last Hope Inlet, Patagonia.

A thermodynamic analysis of the function of the kidney; and some physiological applications: HENRY BORSOOK and HOWARD M. WINEGARDEN (introduced by T. H. Morgan). The work of the kidney in the excretion of urine is analyzed by means of the second law of thermodynamics. The work performed by the normal kidney in man in the excretion of urine is of the order of magnitude of 0.7 gm calories per cc of urine; or 70 gm calories per gram of nitrogen excreted. The production of either hypertonic or hypotonic urine entails work on the part of the kidney; the excretion of a urine which is the same as the plasma in all details incurs no work by the kidney. The energy consumed by the kidney in man in the production of urine was found to be 6–11 kg calories per gram of nitrogen excreted. The normal healthy kidney considered as a chemical machine possesses a great capacity for work but performs its work with an "efficiency" probably not greater than 1 to 2 per cent. The effect of disease is to reduce markedly the capacity of the kidney for work. This conception of renal function permits a correlation of observations on the constitution of amphibian and mammalian urine, *in situ* and isolated, in health and disease; of the effects of drugs, metallic poisons, anemia, cyanide and narcotics on the oxygen consumption of the kidney; and of the observations on the differences in renal oxygen consumption during the excretion of increased amounts of chlorides, sulfates and urea. There is a close correlation between the specific dynamic action of proteins or amino acids and the increase, over the basal level, in the urinary nitrogen. The values of the specific dynamic action of amino acids and of proteins indicate that 25 to 60 per cent. is due to the work imposed upon the kidney; the remainder is due to the metabolism of the constituent nitrogen and carbon, though it is not possible, at present, to estimate the proportion for which each is responsible. This hypothesis accounts for hitherto anomalous phenomena in the specific dynamic action of protein.

Haploid Drosophila and the theory of genic balance: CALVIN B. BRIDGES (introduced by T. H. Morgan). Some animal forms are known in which the cells of certain individuals contain only one set of chromosomes, instead of the usual two sets. These "haploid" individuals, of which the best known are in the bees and wasps, are invariably males. In *Drosophila melanogaster* sex is determined by the ratio between two sets of opposing genes, one set, tending to produce femaleness, being carried in the X-chromosome, and another set, tending to produce maleness, being carried in the rest of the chromosomes. Increasing the relative number of X-chromosomes increases the femaleness. Increasing the number of autosomes increases the maleness of the individual. A ratio (2X: 3 sets autosomes), intermediate between that of the normal female (2X: 2 sets auto-

somes) and the normal male (1X: 2 sets autosomes) gives sex-intermediates or intersexes. Since a similar relation exists for other characters, it is evident that the degree of development of a character is an expression of an equilibrium between genes tending to modify the character in opposite directions. This theory is given the name "genic balance." Now in Drosophila it was found that 2X: 2A, 3X: 3A and 4X: 4A, all 1: 1 ratios, give the female type of characters. Therefore it was predicted that 1X: 1A, or the haploid type, should be female, if the theory of genic balance is valid. No haploid Drosophilas were known, but a method was discovered which would give individuals in whose bodies, in sharply delimited regions, haploid tissue is present. These individuals occur rarely, one in many thousands, among offspring that start as Minute-n females. The gene Mn evidently affects the X-chromosome in which it lies, and to a lesser extent the other maternal chromosomes present in the same egg-cell, in such a manner that they can not maintain the normal division pace. Hence they are all rarely left behind and lost. The cells from which all maternal chromosomes are lost still contain the paternal X and autosomes and give a haploid patch of tissue. For several years attempts have been made to obtain more definite evidence, first, that these patches are actually haploid in the manner just represented, and second, to determine the sex of the haploid regions. The haploid nature of these regions and their femaleness are both now sufficiently established. One recently discovered especially favorable specimen showed in a haploid region the loss of dominant maternal characters which were carried by the three major chromosomes, here eliminated, and the presence of recessive paternal characters which were carried by the three corresponding chromosomes of the father. The sex was diagnosed as female from the darker color of the eosin eye of the region, and from the absence of sex combs, which when present are a distinctive and reliable index of maleness. The unusual nature of the case of a haploid that is female lends strong support to the theory of genic balance, on the basis of which this condition was predicted.

The inheritance of rubricalyx bud color in crosses with Oenothera lamarckiana: STERLING EMERSON (introduced by T. H. Morgan). Three types of F_1 plants, all with *rubricalyx* bud color, are produced in crosses between *Oenothera Lamarckiana* and *Oe. rubricalyx* (Afterglow). The *gaudens* complex of *Lamarckiana* with modified-*velans* of *rubricalyx* produces a plant with the *Lamarckiana* growth habit and a ring of 12 chromosomes and a pair. On inbreeding, *gaudens* · modified-*velans* breeds true for bud color, growth habit and chromosome configuration, indicating that the genes for bud color, growth habit and the zygotic lethals of *gaudens* and modified-*velans* are in the ring of 12 chromosomes. *Gaudens* with *ʰlatifrons* of *rubricalyx* produces a plant which resembles *Lamarckiana* in growth habit and has a ring of 8 chromosomes and 3 pairs. On inbreeding, it produces plants of the F_1 type and a second type which has homozygous *rubricalyx* bud color, the bud shape of mut. *latifrons*, and 7 chromosome pairs. Growth habit is variable in both types. In *gaudens* · *ʰlatifrons*, therefore, the *gaudens* lethal and the gene for *rubricalyx* bud color are in the ring of 8 chromosomes, while some of the genes for growth habit are in some of the pairing chromosomes of the F_1 plant. The *ʰlatifrons* complex carries no lethal, which accounts for the appearance of the segregate with 7 chromosome pairs. The *velans* complex of *Lamarckiana* with *ʰlatifrons* produces a plant with the *rubricalyx* growth habit and a ring of 8 chromosomes and 3 pairs. On inbreeding, four types of plants are produced: *rubricalyx*-habit with *rubricalyx* buds, *rubricalyx*-habit with red buds, *latifrons*-habit with *rubricalyx* buds and *latifrons* habit with red buds. Both types with *rubricalyx* growth habits have a ring of 8 chromosomes and 3 pairs, and both types with *latifrons* growth habits have 7 chromosome pairs. In *velans* · *ʰlatifrons*, therefore, the *velans* lethal and the genes for growth habit are in the ring of 8 chromosomes, while the gene for *rubricalyx* bud color is in one of the pairing chromosomes. The linkage between the genes for *rubricalyx* bud color, growth habit, and the *velans* lethal in certain hybrids is thus due to the association of chromosomes in the rings and not to the presence of all these genes in a single chromosome.

A spectrophotometric study of the pigments in the eye-color mutations of Drosophila: JACK SCHULTZ (introduced by T. H. Morgan). The many eye-color mutants of Drosophila furnish material for the study of problems in the physiology of gene expression. As a first step in such a study, the pigments concerned have been investigated by means of spectrophotometric measurements of their absorption curves. In the twenty eye-color types so far studied three water-soluble pigments—red, yellow and brown—have been found. The first two of these show characteristic color changes with change of pH. The brown pigment, when the solution is made alkaline, darkens, but does not change in color. All three of the pigments follow the portion of an extract which contains the amino-acids; they may possibly be related to this group of substances. Partial separation of the pigments from each other, out of mixtures, has been accomplished in various ways. On the addition of excess acid or on heating the dry pigment, both yellow and red are changed into the brown pigment, which itself is stable under such treatment. As yet the reverse change has not been brought about. The conversion of two of these pigments into the third, as well as the general similarity of their group reactions, indicates that they are closely related. The different eye-colors may be grouped into four general classes, according to the pigments they contain. Three of these correspond to the three pigments, each group containing one pigment in high concentration compared to the others. The fourth group contains those types in which mixtures of the three pigments are present. Genetic combinations have been made of mutants from different groups and the pigments present in these combinations studied. These data may perhaps be interpreted to mean that the genes involved affect the reaction which forms the pigment out of its precursor,

and that these three pigments may possibly have the same precursor.

Function space-time manifolds: A. D. MICHAL (introduced by E. T. Bell). This paper is concerned with one-parameter continuous groups of transformations and their functional invariants in the infinitely many dimensional manifold each point of which has coordinates (y (x), t).

The motion of a solid in a compressible fluid: H. BATEMAN. For the case in which the motion of the fluid relative to the solid is steady and irrotational the equations of motion may be derived from the principle that the pressure-energy of the fluid is stationary in value (a maximum usually) when the mechanical energy per unit volume is a prescribed function of the density. The pressure-energy can be expressed as the volume integral of a certain function of the velocity, and the problem has many features in common with the well-known problem of minimum area associated with the form of a soap film. The case in which the velocity of the fluid is of the same order of magnitude as the velocity of sound in the fluid is particularly interesting both on account of its technical importance and also on account of many peculiar phenomena. The theorem of Prandtl and Glauert relating to the effect of compressibility on the lift of an airfoil is extended to the case when there is a very general type of relation between the pressure and density of the fluid.

Wave motion in a homogeneous absorbing medium: P. S. EPSTEIN.

Velocity-distance relation among extra-galactic nebulae: EDWIN HUBBLE. Earlier investigations have established an approximately linear relation between radial-velocity and distance (the red-shift) among extra-galactic nebulae, amounting to about 500 km/sec per million parsecs and holding out to about two million parsecs. Thirty-four new velocities, sixteen of which are distributed among four very distant clusters of nebulae, confirm the relation in its earlier form and extend the observed range out to about 24 million parsecs. Distances of clusters and groups of nebulae are determined from the mean magnitudes, the zero-point being derived from nebulae in which stars can be seen. Extra-galactic nebulae appear to exhibit a color-excess which is independent of distance and may have its origin in the galactic system itself.

Forbidden iron lines in stellar spectra: PAUL W. MERRILL. The bright-line spectrum of the famous southern variable star η Carinae was well known to astronomers for many years but until recently numerous strong lines remained unidentified. The same lines had been observed in a few other stellar spectra. Shortly after Bowen announced the discovery in the spectra of nebulae of so-called forbidden transitions from metastable states of oxygen and nitrogen atoms, the lines resulting from similar transitions in ionized iron atoms were computed and found to coincide with most of the strong unidentified lines in η Carinae. An essential distinction between these lines and those known in the laboratory is that the probability of spontaneous transition from the initial (upper) state is much smaller. They correspond to quadrupole rather than to dipole radiation. The forbidden iron lines are now known in about twenty stars, including eight or ten associated with class B, one or two of class G, three or four long-period variables just before minimum light, five other red stars and two novae. The spectrum of H.D. 190073 exhibits numerous bright iron lines, although the forbidden lines are apparently absent. It is of especial interest, however, because of the presence of bright sodium lines. Aside from novae this is the first star in which these familiar lines have been observed to be bright.

Mount Wilson measures of lunar and planetary temperatures: EDISON PETTIT and SETH B. NICHOLSON (introduced by Walter S. Adams). The temperature of a planet is given by the general equation $\log T = 2.612 - 0.1 (\overline{m}_r - \Delta m_r)$ where $\overline{m}_r$ is the radiometric magnitude of the planetary heat per square second of arc, and Δm_r is the absorption loss in the atmosphere and the telescope. The radiation from each planet was measured with a thermocouple placed in the principal focus of the 100-inch reflector; the radiated planetary heat, from which $\overline{m}_r$ is obtained, was separated from the reflected sunlight by means of a thin glass absorption screen. The atmospheric absorption was derived by extrapolation from Fowle's laboratory measures of the transmission of water-vapor and from a comparison of measured and computed maximum temperatures on the moon. The radiation from the moon was measured during a total eclipse, and from the rate of cooling some idea of its heat conductivity was obtained. The resulting temperature of the sub-solar point on the moon was 374° K, and of a point on the night-side, less than 120° K. The temperature of a point where the altitude of the sun was about 20° fell from 342° K before the lunar eclipse to 156° K after $2^h\ 40^m$ immersion in the umbra of the earth's shadow. The maximum temperature of Mercury is about 655° K. The distribution of radiation over its surface is much like that on the moon. Venus is covered with clouds and the radiation measured is from the high cloud surfaces and, except by inference, tells very little about the actual surface temperatures. The measured night temperature on Venus is about 241° K which is much higher than that on Mercury or the moon. The temperature on Mars varies greatly with the season and the time of day. With the sun in the zenith at perihelion it measures 296° K; at aphelion this temperature would be reduced 27°. The outer planets are very cold, as might be expected from their great distances from the sun, unless they give off heat from their interiors. The thermocouple measures show that the temperature of Jupiter is about 135° K and, therefore, that very little of the radiated heat comes from its interior.

The photochemical reaction of gaseous iodine with hexene, and the separation of the two types of iodine molecules: R. M. BADGER and J. W. URMSTON (intro-

duced by A. A. Noyes). It was the purpose of the experiments here reported to attempt a separation of the symmetric and antisymmetric types of iodine molecule by means of a photochemical reaction in which one of these molecular types is selectively activated. The selective activation was effected by irradiation with the green mercury line, 5461 Å, which is absorbed by only one of the molecular types, and the acceptor chosen for the activated molecules was gaseous hexene. If the photochemical reaction were of the simplest kind, namely the addition of the activated iodine molecules onto the hexene double bond, the reaction would proceed until half the iodine is used up, the molecules remaining being of the type which does not absorb the green mercury line. Experiments on mixtures with a partial pressure of iodine of about 0.17 mm and of hexene of about 6. mm show that the mechanism of the reaction is actually more complicated, and may possibly involve energy transfers between the two types of iodine, or the production of iodine atoms at some stage of the process. However, fluorescence experiments on mixtures in which half the iodine had reacted indicated a small but definite excess of the molecular type which does not absorb the 5461 Å line, over that found in the equilibrium iodine mixture. This excess does not disappear in several days when the gas mixture is kept in the dark.

The ring structure of mannose: HORACE S. ISBELL (introduced by George K. Burgess). The ring structure of the various forms of glucose and mannose has been the subject of considerable controversy. It has been claimed (Hudson, *Jour. Amer. Chem. Soc.*, 52: 1682, 1930) that a decision between the rival classifications of rings might be obtained from a comparison of the optical rotations of a pair of sugars which can exist only in one ring form. Two pairs of substances which fulfil these requirements, cellobiose and 4-glucosido-mannose, and lactose and 4-galactosido-mannose, were pointed out by C. S. Hudson. A comparison of the approximate rotations of these sugars as given in the literature shows that the difference between the molecular rotations of the first pair differs widely from the value obtained for the second pair. Thus it was necessary to obtain more accurate data upon the rotations of these substances. The preparation of 4-glucosido-α-mannose monohydrate has been repeated and the initial rotation as extrapolated to zero time was found to be $[\alpha]_D^{20} = 14.6$. A comparison of the molecular rotations of cellobiose and 4-glucosido-α-mannose gives an "epimeric" difference of 16,900. This is of the same order of magnitude as the values obtained from α-mannose and α-methyl mannoside, 14,900 and 15,300, respectively, but it differs markedly from the value 6,700 obtained from β-mannose. On the other hand, a comparison of the approximate rotations of 4-glucosido-β-mannose and 4-galactosido-β-mannose indicates that they agree with the value derived from β-mannose. These results are interpreted as indicating that 4-glucosido-α-mannose has a structure similar to α-mannose, while 4-glucosido-β-mannose and 4-galactosido-β-mannose have structures similar to β-mannose. Since the disaccharides just mentioned can not form a 1, 4 ring, probably neither α- or β-mannose has a 1, 4 ring structure.

Crystalline alpha and beta methyl-d-gulosides: HORACE S. ISBELL (introduced by George K. Burgess). The reaction between reducing sugars and methyl alcohol in the presence of hydrogen chloride gives a mixture of isomeric methyl glycosides. Frequently amorphous products are obtained which can not be brought to crystallization by the usual methods. The separation of two isomeric methyl gulosides from such a mixture was accomplished by means of crystalline coordination compounds with calcium chloride. So far as known these compounds are the first compounds of this type to be prepared from the methyl glycosides. The calcium chloride was removed by means of silver oxalate, and crystalline α-methyl-d-guloside (monohydrate) and β-methyl-d-guloside were obtained for the first time. The following new compounds are reported:

α-Methyl-d-guloside $CaCl_2 \cdot 2H_2O$,	$[\alpha]_D^{20} = +67.$
$(\alpha\text{-Methyl-d-guloside})_2\ CaCl_2 \cdot 3H_2O$,	$[\alpha]_D^{20} = +83.$
α-Methyl-d-guloside $\cdot H_2O$,	$[\alpha]_D^{20} = +109.$
β-Methyl-d-guloside $CaCl_2 \cdot 2H_2O$, (approximately).	$[\alpha]_D^{20} = -46$
$(\beta\text{-Methyl-d-guloside})_2\ CaCl_2$,	$[\alpha]_D^{20} = -65.$
β-Methyl-d-guloside,	$[\alpha]_D^{20} = -83.$

BOOKS RECEIVED

CASTLE, W. E. *Genetics and Eugenics.* Fourth edition, revised. Pp. x + 474. 170 figures. *The Genetics of Domestic Rabbits.* Pp. vi + 56. Illustrated. Harvard University Press.

DRACHMAN, JULIAN M. *Studies in the Literature of Natural Science.* Pp. x + 487. Macmillan. $4.00.

HOLMES, HARRY N. *Laboratory Manual of General Chemistry.* Third edition. Pp. x + 163. 34 figures. Macmillan. $1.60.

HULBERT, ARCHER B. *Soil:* Its Influence on the History of the United States. Pp. x + 227. Illustrated. Yale University Press. $2.50.

LUCKIESH, M. *Artificial Sunlight:* Combining Radiation for Health with Light for Vision. Pp. 254. 65 figures. 8 plates. Van Nostrand. $3.75.

LIDDELL, DONALD M. *The Metallurgists' and Chemists' Handbook.* Third edition, revised. Pp. viii + 847. McGraw-Hill. $5.00.

MILLIKAN, ROBERT A., HENRY G. GALE and CHARLES W. EDWARDS. *A Manual of Experiments to Accompany "A First Course in Physics for Colleges."* Pp. vi + 221. 134 figures. Ginn. $1.00.

REYNOLDS, WALTER F. *First-Order Triangulation in Southeast Alaska.* Pp. vi + 157. 24 figures. Coast and Geodetic Survey, U. S. Department of Commerce.

STANDLEY, PAUL C. *Flora of Yucatan.* Pp. 157–492. Field Museum of Natural History. $2.00.

STRONG, RICHARD P., Editor. *The African Republic of Liberia and the Belgian Congo:* Based on the Observations Made and Material Collected during the Harvard African Expedition, 1926–1927. Volume II. Pp. ix + 1064. Illustrated. Harvard University Press. $15.00 for set of two volumes.