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Study of Rapidly Running Transitions at High Pressures

Diamond anvils have been used in a "squeezer-type apparatus to follow high-pressure transitions with a recording x-ray diffractometer. The surface of the diamond presses against a lower Carboloy anvil with the sample, in the form of a thin disk, held between the two surfaces. Clear x-ray patterns are obtained with pellets less than 3 mm in diameter, and they yield information on equilibrium pressure and on transformation rates.

LEASON H. ADAMS, BRIANT L. DAVIS
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Terrestrial Age of Iron Meteorites

We have been engaged in a program of determining the amounts of a large number of radioactive and stable nuclides produced by cosmic rays in iron and stone meteorites. The main purpose of this work has been the study of possible time variations in the cosmic ray intensity over long periods in the past. However, as an interesting by-product, these measurements also provide a method for measuring the time lapse since the fall of the meteorite.

It has usually been assumed that iron meteorites disappear by weathering in a relatively short period, at least in most climates. The meteorite Williamstown contains only about 25 percent of the amount of chlorine-36 (half-life, 3×10^5 years) found in recent falls which are similar in other respects. This indicates a terrestrial age of approximately 600,000 years. This meteorite was found in Kentucky. Recent data of Wanke and others indicates that terrestrial ages of this order of magnitude are not an unusual phenomenon.

The great resistance to corrosion shown by these meteorites is rather puzzling.

JAMES R. ARNOLD
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The Sun's Magnetic Cycle

Observations of the varying pattern of weak magnetic fields distributed over the surface of the sun have been under way with the solar magnetograph for 8 years. Two significant results are as follows: (i) the sun has a poloidal field that reverses its polarity near the peak of the sunspot cycle; and (ii) local magnetic areas, responsible for sunspots and other forms of solar activity, disappear by expanding.

A new theory of the solar cycle based on these findings calls on the differential rotation to draw out the submerged lines of force of the poloidal field into an amplified, shallow, spirally wound sheath, which grows to a critical intensity, necessary for the emergence of unstable bipolar loops, first at moderate latitudes and then progressively closer to the equator, according to the derived formula $\sin \phi_e = 1.5/(n + 3)$. This represents Spörer's law of sunspot latitudes and the Maunder "butterfly diagram." The amplification factor is about 50, and the total length of magnetic "flux rope" formed is ample to account for the few thousand sunspot groups formed in each cycle. The process is repeated every 11 years, with alternating magnetic polarity.

Expanding loops of the field lines above surface bipolar magnetic regions, together with enlargement of these regions, accounts for neutralization and reversal of the initial poloidal field and for the continuing release of detached flux loops of low intensity in the solar corona. The eventual dissipation of the magnetic energy of the flux loops, through Joule heating, is estimated to provide some 10^{36} ergs in each sunspot cycle; this may be a significant energy source for the corona.

HORACE W. BABCOCK
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Photoproduction of Hydrogen Gas Coupled with Photosynthetic Phosphorylation

Cells containing the enzyme hydrogenase are known to produce hydrogen gas from organic substrates. We have recently shown that the photosynthetic sulfur bacterium *Chromatium* (known to contain hydrogenase) can produce hydrogen gas from a reduced sulfur compound (thiosulfate), but only under the influence of light. We have interpreted the photoproduction of hydrogen from thiosulfate by *Chromatium* as another line of evidence for the electron-flow theory of photosynthesis, which ascribes the same primary photochemical act to plants and photosynthetic bacteria: the photoproduction of transferable electrons by illuminated chlorophyll molecules [*Nature* **190**, 601 (1961); **184**, 10 (1959)]. Photoproduction of hydrogen gas thus occurs when thiosulfate donates electrons to chlorophyll (via cytochromes) and hydrogenase catalyzes the combination of these electrons ("expelled" from the light-activated chlorophyll) with protons from the medium. We have now obtained a light-dependent production of hydrogen gas by spinach chloroplasts supplemented with a partly purified hydrogenase from *Chromatium* (free from bacteriochlorophyll) and with cystein as the electron donor. The photoproduction of hydrogen gas by isolated chloroplasts was accompanied by the formation of adenosine triphosphate. These findings provide further support for the identity of the primary photochemical act in plant and bacterial photosynthesis.

DANIEL I. ARNON,
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Studies of Integrative Processes in Cerebral Systems Based on Mathematical Analysis of Electroencephalographic Records

The ubiquitous nature of rhythmic wave processes in cortical and subcortical structures in the normal waking brain has long been recognized. These processes have been shown to occur independently of actual neuronal firing in the majority of the neurons in the participating population, and the relationship of neuronal firing to a particular phase of the wave process has remained unclear. Many investigators have regarded the wave process as a "noise" in the cerebral system, not clearly related to information handling mechanisms.

However, a careful reappraisal of this problem in the electroencephalographic records during training and subsequently during performance of a learned task in animals has disclosed close correlations of phase patterns between different brain regions with the level of learning. In the fully trained animal, further close relationships in phase patterns have been discerned to the correctness or incorrectness of a discriminative motor performance. In these studies, we have used auto-correlation and cross-correlation techniques, and have initiated the use of cross-spectral analyses which permit assessment of phase patterns across a spectrum of frequencies.

In attempting to model a cerebral system, the results suggest the possibility that individual neurons may function as phase comparators for graded, analog wave processes sweeping across their surfaces in spatiotemporal patterns. Electronic wave processes apparently arise mainly in dendritic mechanisms and in presynaptic terminals. Since altered impedance loading offered by adjacent cellular elements on the dendritic electrotonic generator may account for altered frequency patterns, we have developed a new technique for direct impedance measurement, to attempt assess-

ment of relative significance of intraneuronal, intraglial, and extracellular compartments in genesis and modification of wave processes. The proposed model of cerebral neuronal organization would thus be a nonlinear and probabilistic one.

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The 5577-Angstrom Airglow

It was suggested 30 years ago by Chapman that the excitation source of the 5577-A atomic oxygen green line, which is the most intense of the night airglow emissions, lies in the recombination energy of the oxygen atoms that are present in the upper atmosphere as a result of daytime photodissociation. Recent laboratory experiments have shown, however, that the simple three-body atom recombination mechanism that was proposed is not an acceptable physical process to explain the observed upper-atmosphere emission. The following hypothesis of green line excitation is presented here. Two oxygen atoms recombine in a three-body collision to produce an oxygen molecule in an electrically excited state. This excited molecule will either radiate or undergo a deactivating collision with an oxygen atom. If the electronically excited molecule lies in certain vibrational levels, the electronic energy of the molecule may be transferred to the atom to produce an oxygen atom in a ^1S state from which the 5577-A line is subsequently radiated. This hypothesis predicts that at high altitudes the intensity of the green line will be proportional to the square of the oxygen-atom density times the total-particle density, while at low altitudes it will depend on the cube of the atom density. Measurements of the 5577-A intensity variation with height that have been made in Naval Research Laboratory rocket experiments are interpreted to support this theory.

CHARLES A. BARTH
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Rhythmic Oscillations in the Potential of Halicystis

Increased potassium content of the sea water bathing impaled cells of *Halicystis ovalis* (especially in the range 0.12 to 0.18*M* KCl) produces rhythmic decreases in potential, with amplitude up to 80 mv and periods of 8 to 15 minutes. These oscillations often damp out after a few cycles, but occasionally as many as 20 oscillations have been observed. After return to sea water for several hours, the cells can again display the oscillations on exposure to increased concentrations of KCl.

The oscillations have a rapid falling phase, followed by slower recovery, sometimes with a "hump," a "shoulder," or both. The recovery phase often overshoots the original sea-water potential—for example, rising to some 90 mv positive. Increasing the concentration of KCl (to 0.25, 0.3, and 0.4*M*) decreases the magnitude, but not the period, of the oscillations. Decreasing the temperature from 20° to 8° or 10°C increases the period to about 45 minutes.

When oscillations have ceased, illumination of the cell (200 ft-ca) often causes one or more new oscillations, sometimes of greater magnitude than those that occur in the dark. Two or three minutes of such illumination is sufficient to trigger the whole response, and properly phased light and dark periods can generate a long train of oscillations, which, however, eventually damp out, like those that occur in darkness or diffuse light.

The oscillations somewhat resemble those generated in the porous membrane system of Teorell, but the waves are not sinusoidal, no movement of water or change of hydrostatic pressure was observed in inserted capillaries, and electroosmosis cannot be great in the high salt concentrations present (0.6*M*). A rhythmic loss and recovery of sensitivity to the potassium ion is postulated as the cause.

L. R. BLINKS, BARBARA M. POPE
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Problem of Information Transfer in the Brain

The interest of neurophysiologists has long been held by the question of how the brain receives information, both from its external and its internal environments. The era of belief in a ubiquitous all-or-none law for the activity of neurons early focused attention on the discharge of nerve cells, on the temporal and spatial patterns of their firing.

This model, essentially a deterministic one, has inevitably become more complex since microelectrodes have revealed that not all cells signal a given event in the same way; some may start to fire, others may cease their tonic firing, others may reveal some more subtle change. On which of these classes of "coding" is the brain to operate? What is the pattern of incoming message that results in the brain's taking action, for not all afferent impulses evoke an efferent discharge?

In recent years, and stemming largely from an interest in information theory, several workers have been exploring the possibility that a probabilistic model may prove to be a useful hypothesis from which to design experiments.

A probabilistic approach would postulate that information is conveyed by the selection of an item by virtue of its probability of occurrence when compared with a multitude of other possible items. It would be the dissimilar, the novel, the unexpected that would carry the message. Such a concept, then, would require study of average activity, for the brain would take action only when the average activity differed significantly from that to be expected by chance.

The deterministic model makes the assumption that the codes lie in the behavior of the single units and that some massive computational analysis of these individual reports is made by the brain.

The probabilistic model makes the assumption that it is the profile of activity in a population of neurons that is the determining factor.

An experimental exploration of the latter approach will be reported.

MARY A. B. BRAZIER
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Photoelectric Test of World Models

The most powerful test of world models is the relationship between the red shifts and the bolometric luminosities of galaxies belonging to clusters, but red shifts considerably beyond the usual spectrographic limit at $\Delta\lambda/\lambda \sim 0.2$ are needed to make this test decisive. The red shifts of three clusters of galaxies beyond $\Delta\lambda/\lambda \sim 0.2$, as well as those of five nearer clusters, have been observed by a completely photoelectric method undertaken in 1955. Galaxies are measured photoelectrically at six or eight wavelengths ranging from 3700 A to 1 μ, and the observations are translated into spectral-energy distribution curves. These curves are displaced from one another both in wavelength and in luminosity. The wavelength displacement yields the red shift.

The largest red shift thus observed photoelectrically is $\Delta\lambda/\lambda = 0.44 \pm 0.03$ ($\Delta\lambda/\lambda$ = about 132,000 km/sec) for the faint cluster of galaxies found by Minkowski in the position of Cambridge Radio Source 3C295. This result is confirmed by Minkowski's spectrographic detection of an emission line, evidently O II 3727, at 5448 A.

Pending further work, the results to date favor an exploding universe which will collapse again after a long time. Compatibility with the steady-state universe of Hoyle, Bondi, and Gold appears unlikely.

WILLIAM A. BAUM
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Evidence for a Category of Electroreceptors in the Lateral Line of Gymnotid Fishes

A glass capillary ultramicroelectrode was inserted into the exposed lateral line nerve of otherwise intact *Gymnotus* and *Hypopomus*. Spike activity of single fibers was recorded while the fish maintained the normal continuous discharge of the weak electric organs. The only activity in the fibers here reported is a short burst of spikes at 200 to 500 per second, following each discharge (3 to 30 per second) of the electric organ. The number of spikes in a burst changed systematically as conductive objects came near. A small conductive object right over the receptor decreased the number; when the object was just in front of or behind the receptor, it increased the number. Moderate water currents or stroking the skin with a soft brush caused

no spikes. It is concluded that these fibers serve as true electroreceptors.

An imposed pulse of current in the water produced a similar burst of spikes at the onset in one polarity, at the termination in the opposite polarity. The threshold was 5 to 30 mv/cm in the water near the surface of the fish. Sensitivity to changes in imposed current above threshold is high: an additional impulse in each burst is produced by an increase of 1 to 10 percent in pulse voltage. Increasing the duration of the imposed pulses from 1 to 4 msec caused an increase in the number of spikes, but a further increase from 4 to 100 or more msec added no more spikes to a burst of, for example, 20 msec duration. The voltage is coded in the burst, with the time constant shorter than an ordinary burst or a normal interval between the discharges of the electric organ.

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Experimental Evidence for a Basal Slip Mechanism in Quartz

Large plastic deformation of single crystals of quartz and well-bonded quartzite has been achieved for the first time in the "cubic" high-pressure device of Griggs, at temperatures from 300° to 1300°C and confining pressures from 14 to 40 kb. Single crystals of several orientations have suffered plastic deformation in compression. The deformation is not at all homogeneous, and specimens shortened by more than 1 percent are characterized by deformation bands, deformation lamellae, or continuous bending of the lattice (undulatory extinction). The structures were examined in thin sections with a polarizing microscope and universal stage. In crystals deformed with high shear stress on the basal plane, deformation bands almost parallel to the *c*-axis and lamellae almost parallel to the base are well-developed; lamellae parallel to the *c*-axis, associated with bands parallel to $\{0001\}$, are also present, but rare. Textural relationships of bands and lamellae suggest that the lamellae are very thin deformation bands. Lattice rotations within deformation bands parallel to the *c*-axis strongly suggest that the deformation mechanism is slip on $T = (0001)$. The near-basal bands and lamellae are interpreted as bands of secondary slip. There is evidence that the direction of slip (t) varies with the conditions of deformation. Crystals deformed so that the shear stress on $\{0001\}$ is low or zero do not contain structures with the above orientations but show bands and lamellae of other orientations. Since these cannot be produced by basal slip, other slip mechanisms must also operate. Evidence from deformed polycrystalline aggregates indicates that basal slip takes place at lower stresses than the other mechanism or mechanisms.

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Mutational Studies in Serratia marinorubra

Two marine bacteria which have been studied have exhibited singular genomic stability in respect to ultraviolet-induced mutations. Various investigators have proposed that divalent ions, specifically Ca^{++} and Mg^{++}, might bridge negatively charged sites and impart structural stability to the chromosome. Kirchner and Eisenstark [*Bacteriol. Proc. Soc. Am. Bacteriologists* **21** (1957)] observed that genetic exchange occurred with an increased frequency in chelated or divalent ion starved cells. These observations led to an investigation of the possible role of divalent ions in stabilizing the genome of *Serratia marinorubra*, a representative marine organism.

Ultraviolet irradiation experiments in which cultures grown in the presence and in the absence of magnesium (the sole divalent cation in our defined medium) were compared yielded approximately a tenfold increase in recovery of mutants from the Mg^{++}-deficient cultures. Survival after ultraviolet irradiation is not affected by deletion of Mg^{++}. These data are tentatively interpreted as supporting the theory of a structural role for Mg^{++} in native genetic material.

Recent observations by W. Hastings indicate that deletion of Mg^{++} also yields increased numbers of mutants in *Achromobacter fischeri*.

WILLIAM L. BELSER
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Radiation Damping of Spinning Particles

The disagreement in the literature on the basic classical equations of a spinning particle is summarized and the relations between the various theories are outlined. The theory of a charged particle with spin is developed for the case in which radiation damping is included and the particle may possess a moment of inertia about an axis orthogonal to the spin. It is found that the radiation damping terms may be formally eliminated from the equations of motion by redefining the momentum, mass and rate of change of spin. The redefined mass is no longer a constant of the motion and the supplementary condition, that the polar vector associated with the spin should vanish in the rest system, does not hold for the redefined spin.

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Bacteriophage MS2: Another RNA Phage

Bacteriophage MS2, isolated by John Clark as a phage which attacks an F^+ strain of *Escherichia coli* but not a corresponding F^- strain, appears to be an RNA-containing bacteriophage, similar to the f2 of T. Loeb and N. D. Zinder [*Proc. Natl. Acad. Sci. U.S.* **47**, 282 (1961)]. The phage is lysis-inhibited and provides a burst size of 10,000 to 20,000. It bands at a density of 1.46 in a CsCl gradient. It has an S_{20} of 81. Electron micrographs indicate a polyhedral structure of diameter about 24 mμ.

Nucleic acid, obtained from MS2 by phenol treatment, is infective to bacterial protoplasts [G. D. Guthrie and R. L. Sinsheimer, *J. Mol. Biol.* **2**, 297 (1960)]. This infectivity is destroyed by ribonuclease but not by deoxyribonuclease (reciprocal controls were performed with the infective DNA of bacteriophage ØX 174). The nucleic acid is infective to protoplasts of F^- strains as well as to protoplasts of F^+ strains.

JAMES E. DAVIS
JAMES H. STRAUSS, JR.
ROBERT L. SINSHEIMER
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Evaluation of Studies on Ultrastructure of Sieve Plates

The connecting strands of *Cucurbita* have a variable appearance under the electron microscope. Some views suggest intervacuolar connection between sieve elements through strands that appear to have an outer layer of cytoplasm and an inner core of vacuolar material; others show solid connecting strands. These variations may be traced, in part, to methods of preparing the material. The papers published thus far show solid connecting strands or strands resolvable into a system of fibrillar elements. Before the attempt is made to relate the ultrastructure of the sieve plate to the movement of solutes in the phloem, one needs to know which view illustrates most accurately the condition in the intact plant. The composition of the connecting strands in sieve plates cannot be fully determined until the relation between slime and cytoplasm in mature sieve elements is understood.

KATHERINE ESAU
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Isotopic Geochemistry of Volcanic Water and Steam

Isotopic, chemical, and field studies of waters and gases in geothermal areas have been made with the objective of determining the proportions of "juvenile" components from magmatic sources, and of "recycled" components, derived from material previously at the surface of the earth. Deuterium and oxygen-18 concentrations in surface meteoric waters of the earth vary by about 43 and 5.6 percent respectively, and are linearly related. These variations furnish natural isotopic tracers for the study of geothermal water and steam from areas with surface waters of quite different isotopic composition.

The deep circulating, nearly neutral *p*H, thermal springs, and volcanic steam of high pressure and temperature, show a characteristic "oxygen isotope shift," such

that the oxygen-18 concentration is increased, but the deuterium concentration is the same, relative to the isotopic composition of the local meteoric waters. This effect appears to reflect exchange of oxygen with rocks, and possible loss of vapor at temperatures of about 200°C at which there may be oxygen isotope, but no hydrogen isotope, fractionation. From these data it is possible to place limits on proportions of juvenile water in the areas studied.

Superficial acidic springs are characterized by quite different relations, reflecting a kinetic isotope effect in the evaporation of local surface waters. Such an effect also characterizes the evaporation of natural waters at ordinary temperatures. Low P and T steam fumaroles contain steam boiling off the water table in isotopic equilibrium.

HARMON CRAIG
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Evaluation of Studies on Ultrastructure of Tonoplast in Sieve Elements

The tonoplast has received relatively little attention in studies on the ultrastructure of plant cells. Published reports and our studies indicate that preservation of the tonoplast must be carefully investigated, especially in sieve elements because their mature protoplasts are so easily injured. Our comparison of young and old sieve elements of *Cucurbita* supports the concept that during nuclear disintegration the organelles, the cytoplasmic membrane systems, and the tonoplast break down. The ectoplast and the remnants of the other cytoplasmic structures appear to constitute the characteristically thin parietal cytoplasmic layer in mature sieve elements. This study stresses the importance of the ontogenetic approach in the study of the tonoplast, particularly in such a highly specialized cell as the sieve element.

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Transfer of Transplantation Immunity by Sensitized Lymphoid Cells

Mouse lymphoid cells were sensitized to skin homografts and were labeled with tritiated thymidine. When transferred to isologous hosts, the sensitized cells rejected the homologous skin grafts in an accelerated fashion, and few or no labeled lymphocytes were present in the rejection site. Mouse lymphoid cells were sensitized to skin homografts and within Millipore chambers were transferred to isologous hosts. The homologous skin grafts were rejected in an accelerated fashion when the chambers were placed subcutaneously at the periphery of the graft or intraperitoneally. There was no evidence of sensitized cells escaping from the chambers.

JOSEPH D. FELDMAN
JOHN S. NAJARIAN
Scripps Clinic and Research Foundation, La Jolla, California

Quality of Piano Tones

Usually a pure tone is described by two parameters—namely, the frequency, in cycles per second, and the intensity level, in decibels at the ear of the listener. Similarly, a piano tone is thought of as a summation of pure tones which differ in intensity level and have frequencies which are integer multiples of the lowest frequency, called the fundamental.

This picture is far from adequate to describe the quality of piano tones produced by musicians. One must also describe the starting and stopping characteristics of the tone, called the attack and decay. Physicists have usually assumed that the decay of the component tones is logarithmic—that is, that the intensity level, in decibels, decreases uniformly with time. This is far from the truth, as will be shown by a careful analysis of such tones. For some of the components, the decay looks more like sinusoidal time variations than like logarithmic ones. In this paper typical curves showing such variations are given for as many as 30 overtones of a piano tone.

Also, it has been found that the frequencies of the component tones are not multiples of the fundamental—that is, they are not harmonic tones. For example, the measurements showed that for the note G‴, the 33rd overtone was sharp from a harmonic series by as much as four semitones, the fundamental being 27.5 cy/sec and the 33rd overtone being 1144. It is this lack of harmonicity that gives the piano its characteristic quality, especially for the low-pitched tones below middle C.

A synthesizer was built which could produce 100 components having any frequency and intensity level. By means of dials and electronic controls, the attack and decay times could be set at any values between 0.001 second and 10 seconds. This machine was used to imitate actual piano tones and particularly to produce tones which were thought to be preferable from a musician's viewpoint.

A jury of musicians and also a jury of nonmusicians made judgment tests of these tones. In some cases the synthetic tones were preferred to the real piano tones, but in most cases it was difficult to improve upon the real piano tones, at least as judged by the musicians. A tone was tried which had components that were exact harmonics and intensity levels that were the same as those of the real piano tone. The tone with the inharmonic frequencies was definitely preferred by the musicians. They said that the tone with harmonic components sounded like an organ that had attack and decay characteristics like a piano. Some of the musicians expressed a desire to have available many of the synthetic tones but said these could not be called piano tones.

Piano-like tones resulted from the synthesizer when the attack times (the time required to reach 0.9 of the tone's maximum intensity) ranged from 0 to 0.01 second for notes below G and from 1 to 4 seconds for notes above G.

The overtone structure could vary over wide ranges and still the tone would be piano-like. For example, here are the limits on overtone structure for a synthetic tone to be piano-like.

1) The intensity level of each overtone above the 5th should be between 1.5 and 2.5 decibels lower than that of the preceding one.

2) When the intensity level per overtone is higher than 2.5 decibels per overtone, the tone sounds more like a kettledrum.

3) When the intensity level is less than 1 decibel per overtone, the tone is too edgy and approaches the sound of a harpsichord. When very small, the tone becomes like the noise made by hitting a metal plate.

4) The relative intensity levels of the first five or six overtones can be changed in almost any manner and the tone, although its quality is changed, will remain piano-like.

5) The overtones must be inharmonic or the piano-like quality, particularly the liveness, is lost.

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Modulated Beam Experiments on Gas-Surface Interactions

The application of modulated atomic beam techniques to the study of the physical and chemical reactions between gases and solid surfaces has permitted the measurement of a number of parameters of these reactions and also has displayed a number of unexpected phenomena. The experiments have been of two types. In the first, a beam of atoms or molecules impinges against a solid surface, and particles leaving the surface are detected by a mass spectrometric neutral beam detector. Rotation of the detector permits measurement of angular distributions of the emitted particles, and signal strengths are used to deduce chemical and physical reaction probabilities and coefficients. The second type of experiment observes, through mass spectrometric detection, those particles emitted normal to a surface when particles from a hemispherical gas source impinge against it. In both cases, modulated techniques are employed to achieve clear distinction between the desired effects of the beams and effects arising from the residual gas in the vacuum of the atomic beam apparatus, and to determine reaction times in certain processes.

Among the processes for which quantitative information will be presented are condensation of gas molecules at surfaces, dissociation of hydrogen at hot tungsten, and thermal accommodation. Among the unexpected, and as yet inadequately explained, observations to be discussed are anomalous angular distribution of reflected particles and apparent time delays in certain chemical reactions.

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Displacement of the San Andreas Fault in Southern California

Three segments of a former east-west trending belt of terrane in southern California are interpreted as displaced horizontally about 130 miles on the vertical San Andreas fault and 30 on its branch, the San Gabriel fault, since the earliest Miocene. The terranes displaced by the San Andreas fault are characterized by distinctive rocks which range in age from Precambrian (?) to Lower Miocene. Basement types include augen gneiss and blue-quartz gneiss of the amphibolite facies which have been intruded by a complex of gabbro, diorite, anorthosite, and syenite, and all intruded again by granitic rocks. Associated distinctive rocks on both sides of the fault include basic dikes and mafic bodies rich in ilmenite and apatite, blue-quartz granite, quartz-bearing syenite, granophyre, and pegmatite. Greenschist, marine Eocene strata, and Oligocene nonmarine beds and volcanics are also displaced. The San Gabriel fault separates similar rocks except for the anorthosite-syenite complex.

This combined displacement of 160 miles appears to be compatible with other studies along the San Andreas system. Younger and smaller displacements seem geometrically sound, but greater displacements of older features rest on arguments of a different order of acceptability. Additional study of the geology along faults for many miles is needed with emphasis on geometric analysis of gross elements and on a search for linear features, such as basin-margin lines and facies-change lines, to establish slip. Separations of low dipping units require study, and the possibility that such units have been displaced by trace slip needs more widespread recognition.

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Radiocarbon from Nuclear Tests and Atmospheric Circulation

The recent increase of the C^{14} level in the atmosphere caused by the testing of thermonuclear weapons has been well established by many laboratories, and the measurements of this increase have been of assistance in studies of global atmospheric circulation. Over the period 1955–59 the C^{14} level in the Northern Hemisphere troposphere rose to 30 percent above normal, while during 1960 a decline was observed, showing that the transfer of C^{14} out of the troposphere into the ocean was greater than the transfer of C^{14} from the stratosphere. The C^{14} level in the Southern Hemisphere troposphere lagged behind that in the Northern Hemisphere over the period 1955–59, but equilibrium was reached in 1960, showing that the mixing rate between the two tropospheres is relatively rapid, about 1 or 2 years.

The sampling methods that have been used for all these measurements require a minimum of 3 days' continuous collection to obtain enough sample for C^{14} analysis. As use could be made of such C^{14} analyses for many local atmospheric circulation problems if the sample could be collected more quickly, alternative sampling methods have been considered. A new method of sampling with molecular sieves, which can collect 10 liters of atmospheric carbon dioxide per hour, is now in routine use. Since the molecular sieves collect water as well as carbon dioxide, they operate most efficiently when the water content of the air is low. Some preliminary results that have been obtained with this sampler at sea level and in commercial jet aircraft flying at 30,000 feet will be presented.

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Patterned Responses in Second-Order Neurons of the Olfactory Bulb

The responses of the second-order neurons which receive impulses from the olfactory receptors are quite complex, since they show various patterns of inhibition and excitation to odoriferous stimuli. This patterning may be explained (i) on the basis of a mechanical factor, perhaps a boundary-layer phenomenon due to local air turbulences in the nasal passages; (ii) by the complexity of the synapse at the glomerulus; (iii) by local feedback paths of an inhibitory (negative) character which we can demonstrate in the bulb by antidromic stimulation of mitral axons; (iv) by a similar feedback path between the two bulbs through the anterior commissure antidromic stimulation of tufted cell axons; or (v) by feedback paths from other structures in the brain, notably the midbrain tegmentum.

In recent and so far unpublished work with Mancia and von Baumgarten, evidence for each of these effects has been obtained. From a physiological standpoint it is interesting to note that one implication of our results is transmission of information in the brain by the inhibition of spontaneously active neurons as well as by excitation. The observation has been made that an odor to the ipsilateral nostril may have a completely different effect from the same odor to the contralateral nostril in rabbits, despite the subjective impression of similarity of odor from either nostril in man. A second curious observation is that stimulation of brainstem structures may reverse the effect of an odor on the firing pattern of the cell, converting excitation to inhibition or vice versa.

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Differentiation of Divergent-Production (Creative) Abilities in Young Adolescents

Earlier research on abilities believed to be important in creative thinking led to the differentiation by factor analyses of different skills, most of which have been classified under the headings of fluency of thinking, flexibility of thinking, and elaboration. All of these kinds of ability belong in a larger category called "divergent production," for, in tests of such abilities, the examinee is given certain information from which he is to generate a variety of other items of information; there is no one right answer, but there is a potentially large number of acceptable answers.

Previously, the demonstration of different divergent-production abilities had arisen from the testing of groups of adult, young males, with I.Q. ranges above 100. The study reported was designed to see whether the same differentiations could be demonstrated in younger subjects, of both sexes, and at moderate I.Q. levels.

Four new factor analyses were performed on test scores obtained from several hundred 9th-grade students—one for boys and one for girls of moderate I.Q. levels, one for both boys and girls with I.Q.'s of 120 and above, and one for the whole range of 9th-grade students at one school.

Essentially the same factor structure was found in all the 9th-grade groups as in the adult groups. From a limited battery of tests given to 6th-grade students, much the same differentiations in kinds of ability were also found. In all groups, tests of divergent-production abilities proved to be relatively independent of tests used to measure the I.Q.

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PHILIP R. MERRIFIELD
ANNA COX
University of Southern California

Environmental Carbon Dioxide Concentration and Carbohydrate Metabolism in Liver

In the course of exploring, in vitro, environmental factors, such as *p*H, that quantitatively alter the pathways of carbohydrate metabolism in liver, it was observed that buffers other than bicarbonate-carbonic acid interfered with the conversion of glucose to glycogen. This led to the further observation that increasing the bicarbonate concentration in the incubation medium between 5 and 40 m*M* materially increased the amount of glycogen synthesized from glucose. This has also been found to be true with fructose, but not with pyruvate as substrate. In these experiments, the *p*H of the medium was held constant by appropriately varying the CO_2 tension.

When $HC^{14}O_3$ was used with unlabeled substrates, it was found that the percentage of $C^{14}O_2$ incorporation into liver glycogen is not influenced by the concentration of HCO_3 in the medium. This result, coupled with the lack of effect of HCO_3 concentration on conversion of pyruvate to glycogen, makes it seem unlikely that the primary effect of HCO_3 concentration resides in carboxylation reactions.

On the other hand, paired experiments with C^{14}-labeled glucose plus unlabeled fructose and with C^{14}-labeled fructose and unlabeled glucose indicate that an increase in HCO_3 concentration increases the degree of substrate phosphorylation.

The effect of varying *p*H, both by varying CO_2 tension with constant HCO_3 con-

centration and by varying HCO_3 concentration with constant CO_2 tension, has also been studied in relation to glycogen synthesis from different substrates.

The implications of these observations for the relation between carbohydrate metabolism and pathological variations in acid-base balance will be discussed.

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Scripps Clinic and Research Foundation, La Jolla, California

Ion-Exchange Chromatography in Study of Complex Systems of Coordination Complexes

The power of ion-exchange chromatography in the investigation of the kinetics and stereochemical results of substitution reactions of coordination compounds will be illustrated by examples chosen mainly from the recent work of the author and his associates on reactions of chromium(III) complexes, with emphasis on the combining of ion-exchange chromatography with chloride-ion titrimetry and absorption spectrophotometry to resolve the products and follow the kinetics in the complex system formed when dichlorobis(ethylenediamine)-chromium(III) cations undergo aquation and isomerization reactions with ultimate formation of hexaquochromium(III) cation. In the latter system there appear to be 11 interconverting chromium(III) species, for which 22 rate parameters have been evaluated.

CLIFFORD S. GARNER
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Effects of Steroid Antifertility Agents on Brain Function in Rabbit

The steroid sex hormones (estrogens, progestogens, and androgens) influence reproductive behavior and the release of gonadotropic hormones from the anterior pituitary gland. Differential blockade of the latter phenomenon, leading to temporary sterility, characterizes the action of new progestational antifertility agents which have already proved effective in women. In studies on nervous control of release of pituitary gonadotropin and ovulation in the rabbit, the effects of sex steroids on brain function have been investigated. Permanent electrodes have been implanted into the cerebral cortex and deep regions of the brain, and stimulation and electrical (EEG) recording studies have been conducted in the conscious, freely moving animal. The effects of treatment with steroids on two thresholds have been assessed: (i) an EEG-arousal threshold involving high frequency direct electrical stimulation of the midbrain reticular formation and (ii) an EEG-afterreaction threshold involving low frequency stimulation of the hypothalamus or rhinencephalon. The EEG-arousal threshold has been related to estrous behavior, whereas the afterreaction threshold is closely associated with the facility with which pituitary gonadotropin is released. High dosages of estrogen or androgen maintain a low arousal threshold and an estrous condition, together with an elevated afterreaction threshold and blocked ovulation. However, undesirable side effects limit the usefulness of estrogen and androgen as antifertility agents. The newer progestational antifertility agents, including norethynodrel and norethisterone, differentially elevate the EEG-afterreaction threshold and appear to exert their critical blocking action on release of pituitary gonadotropin by this effect on the brain. In confirmation, the implantation of crystalline sex steroids directly into the hypothalamus inhibits the release of pituitary gonadotropin, whereas steroid implantation into the pituitary gland does not.

M. KAWAKAMI, CHARLES H. SAWYER
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Occurrence of Cellular Inducer of Galactose Metabolism in Mutants Defective in Galactokinase

The regulation (induction or repression) of the biosynthesis of the three *Escherichia coli* K-12 enzymes of galactose metabolism (K, T, and E) is of the coordinate type (M. B. Yarmolinsky, H. Wiesmeyer, E. Jordan, 26th Cold Spring Harbor Symposium, 1961; G. Buttin, *ibid.*). A number of mutants defective in galactokinase (K) have been shown to synthesize the next two members of the galactose sequence (transferase T_1 and epimerase E_1) without the usual repression (H. M. Kalckar and T. A. Sundararajan, *ibid.*). This break in the repression (seen in wild type K-12 *Salmonella* as well as in mutants defective in T and E) is probably not due to lack of repressor. Transduction of a K^- genotype (phenotypically derepressed with respect to the galactose sequence) by a λ gal stemming from a repressor minus strain (G. Buttin, *ibid.*) nevertheless provides a repressed heterogenote (M. B. Yarmolinsky, H. Wiesmeyer, E. Jordan, *ibid.*). The most plausible explanation for this complementation would be that galactokinase plays a role in the removal of a cellular inducer (H. M. Kalckar and T. A. Sundararajan, *ibid.*). Accumulation of sugar components characteristic for the K^- strains can actually be demonstrated. Their possible relation to or identity with occurrence of an endogenous inducer is now under study.

H. M. KALCKAR, T. A. SUNDARARAJAN
Johns Hopkins University

Some Highlights from the Natural Radiocarbon Datings of La Jolla Laboratory

The La Jolla radiocarbon laboratory, established and supervised by Hans E. Suess, has made noteworthy contributions to a wide range of natural sciences.

Many tests bear on geologic events, particularly changes in sea level. For local areas, datings indicate that the sharp rise between 10,000 and 7000 years ago was then slackened but continued almost or quite to the present. Two tests indicate unexpectedly rapid aggradation of the Los Angeles Plain.

Coupled with faunal evidence and O^{18}/O^{16} measurements, datings indicate a warmer-than-present ocean surface (and, by correlation, warm air temperatures) along the California coasts from 7500 to 1600 years ago, with a cold period from 1600 to 600 years before the present (B.P.), followed by return to warmer temperatures. Geomorphic and ecologic data, and habitational evidence in now parched areas, indicate greater-than-present rainfall during several millennia preceding the extreme drought of the past few centuries along these coasts and the adjacent deserts.

The last main stage of Lake LeConte is dated from 1580 B.P. until just before the exploration of the basin. Final recession of Lake Mohave is dated at 9640 B.P.; Lake Manix is dated at 19,500 years.

Pleistocene mammals of the La Brea tar pits are dated at 14,400 B.P.; the extinction of giant marsupials in Australia, at 26,300 B.P.

These and many other dates bear on the antiquity of man. Other dates bear on human prehistory, with particular reference to the paleoecology of man. Three dates bear on Mayan chronology, including one of the oldest known (2200 B.P.)

CARL L. HUBBS
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Tidal Winds and Pressure Changes in the Mesosphere

Determinations of air motions in the layers betwen 80 and 100 km by means of radio meteor observations have shown that the winds in this region undergo large tidal variations, with periods of 12 and 24 hours and with amplitudes of the same magnitude as the mean winds. From these wind oscillations the corresponding pressure oscillations can be computed under plausible assumptions. These computations show that the pressure amplitude is about 5 percent or more of the mean pressure (corresponding to a vertical displacement of the isobaric surfaces through 600 m or more during a period), while at the earth's surface the amplitudes are only about 0.1 percent of the mean pressure. This increase of the amplitudes is expected from the theory of atmospheric tides. At the earth's surface the diurnal oscillation is much less well developed and much more irregularly distributed than the semidiurnal oscillation, but in the high atmosphere both oscillations appear to be of equal importance and of equally regular distribution over the globe.

Both oscillations show pronounced seasonal variations in the high atmosphere, much larger than at the earth's surface. For the semidiurnal oscillation these seasonal changes are in the same sense as those at the ground. In the case of the diurnal oscillation the seasonal variation is such as would be expected if the oscillation were produced by a thermal cause.

B. HAURWITZ
University of Colorado

Evidence Concerning Liquid Structure

In dealing with the theory of the liquid state, some authors have applied quasi-crystalline models, using terms such as *lattices, cells, holes, vacancies,* and *dislocations.* Eyring considers a liquid to be a mixture of "solid-like" and "gas-like" molecules.

I and others have adduced a variety of experimental facts indicating that the molecules of nonpolar liquids are in a state of maximum disorder. I here present one more piece of evidence.

Meta- and para-xylenes boil within 0.8° of each other, and their molal volumes between 100° and 15° parallel one another within 0.4 percent. Para-xylene freezes at 13.2°, meta-xylene at −47.9°, but the molal volume of para-xylene down to 15° gives no premonition of its freezing at 13.2°.

J. H. HILDEBRAND
GRAHAM ARCHER
University of California, Berkeley

Genetic Studies of Double Mutants at the td Locus of Neurospora crassa

Previous investigations dealing with primary CRM negative tryptophan synthetase mutants suggest that multisite lesions might be required for the formation of mutants of this type.

In the present investigation several CRM negative double mutants were obtained from a CRM^+ mutant by appropriate selection techniques, and three of these have been studied in detail. Evidence obtained from crosses involving these strains and from reversion studies suggest that CRM negative double mutants differ markedly from primary CRM^- mutants, and suggest that these latter mutants are not multisite. The significance of these mutants for investigations dealing with the general problems of genic control of enzyme structure and interference phenomena observed in the mapping of closely linked alleles will be discussed.

SAM KAPLAN
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Occurrence of Gas Hydrates in the Solar System

The gas hydrates are clathrate compounds of gases in a distorted ice matrix. The dissociation pressures of methane, ethane, ethylene, acetylene, and carbon dioxide hydrates in equilibrium with ice and gas were measured at low temperatures. The dissociation pressures of a mixed hydrate—for example, a mixed hydrate of methane and ethane—can be estimated from the dissociation pressures of the pure hydrates. From these data it appears likely that methane hydrate or a mixed hydrate of methane, ethane, ethylene, and hydrogen is present on Uranus, Neptune, and the satellites and rings of Saturn. This hydrate is possibly present on Saturn, Jupiter, and the satellites of Jupiter. A carbon dioxide hydrate, or a mixed hydrate of carbon dioxide and sulfur dioxide, is possible on Venus, but metastable ice would have to be present in the clouds. A mixed hydrate of nitrogen, carbon dioxide, and argon may exist at the polar caps and in the atmosphere of Mars, but this possibility also depends on the presence of metastable ice. Hydrates of air may be formed in the high clouds of the earth from either metastable ice or supercooled water. A mixed hydrate of methane, carbon dioxide, ethane, and so forth is likely to be present in comets. It is possible that hydrates are present in particles of interstellar dust.

STANLEY L. MILLER
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Progress in the Theory of Alpha Decay

Attempts have been made, mainly by H. J. Mang at the Theoretical Physics Institute of the University of Heidelberg, Germany, to understand how the α-particle is generated at the nuclear "surface" and is injected into the Condon-Gamow potential barrier surrounding the nucleus. Many experimental features can thus be accounted for in detail on the basis of the nuclear shell model in the region of the doubly closed shell nucleus Po^{208}. For example, the sudden increase of the transition probability above the neutron number 126 is traced back to the difference in angular momentum of the individual nucleon orbits before and after shell closure, and not to an assumed increase of the nuclear radius, as previously suggested by several authors. The theory explains quantitatively the fine structure of α-decay, exhibited in the branching ratios of transitions to different states of the daughter nucleus, as well as the angular correlations between α-rays and subsequently emitted γ-rays.

By this theoretical development α-decay studies can now be used as a source of information about the properties of nuclear states, especially spin assignments, with the same reliability as β- and γ-radiation studies have been used hitherto. The spin of the metastable state of Po^{211} has thus been uniquely determined to be as large as 25/2 units of Planck's quantum.

On the same theoretical basis Mang and Rasmussen (Radiation Laboratory, Berkeley) have jointly begun to study the α-decay of highly deformed nuclei; they have obtained very promising preliminary results.

J. H. D. JENSEN
University of Heidelberg

COSPAR International Reference Atmosphere 1961

The results of an international study group, sponsored by the Committee on Space Research, are presented. The purpose of the group was to study upper-atmosphere properties by rocket and satellite observations. Upper-air densities have been obtained for the region from 200 to 800 km. The observed day and night variation of densities has led to a set of three numerical tables, called "average values," "average minimum values," and "average maximum tables." Related properties such as pressure, scale height, and temperature have been derived from the densities. It is shown that at an altitude of about 800 km, the temperature between daytime maximum (14 hr local time), and nighttime minimum (5 hr local time) might vary by as much as 600 degrees. These findings are based primarily on observations made during the years 1958–59 and on some observations made during 1960; that is, they apply to years of relatively high solar activity. Because of the "solar activity effect," the numerical values may vary during an 11- or 10-year solar cycle.

The accepted CIRA 1961 (COSPAR International Reference Atmosphere) tables have been compiled by R. L. F. Boyd, University College, London; H. LaGow, National Aeronautics and Space Administration, Washington; S. M. Polovskov, Academy of Sciences, Moscow; W. Priester, Sternwarte der Universität, Bonn; and this writer as the chairman of the group.

The work has been carried out with the additional support of the National Academy of Sciences and the University of California, Los Angeles.

HILDE KALLMANN-BIJL
Rand Corporation

Dispersion of Earthquake Surface Waves by a Shoaling Crustal Structure

It has been suggested that the dispersion of earthquake surface waves be used as a diagnostic tool in the determination of crustal and near-mantle structure. The problem is relatively simple to define and solve when the structures may be considered as "flat" or one-dimensional. A point of major departure from this type of structure occurs in the transition of the relatively thin oceanic crust to the thicker continental crust at the continental margins. The problem also arises in considering the structure of mountain ranges and the nature of edge waves in the ocean over a flaring continental shelf.

The problem is solved for the case of Love waves by a direct application of the method of images, developed originally by Sezawa, to the problem of wave propagation in a wedge-shaped crust underlain by a homogeneous mantle. The solution is expressed as a series. It is necessary to sum the series in order to find the singular points. This is done by a perturbation method for small values of the wedge angle. The solution is not restricted to the lowest orders however.

In the first order, the solution is that of a "flat" structure of crustal thickness equal to that below the point of observation. The higher-order corrections correspond to the influence of the inclined bottom of the crust. An interesting feature is that the perturbation may be expanded in a power series in the square root of the wedge angle. Numerical examples are provided.

L. KNOPOFF
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Endogenous Cofactors in Bacterial Photophosphorylation

This work was performed while we were in residence at Brandeis University and was supported by grants in aid from the National Institutes of Health (C-3649) and the National Science Foundation (G-6441).

Cell suspensions of *Rhodospirillum rubrum* yield, on sonification, chromatophores which can be depleted by washing with Tris buffer (*p*H 8) to give minimal photophosphorylation and dark phosphorylation rates. Restoration to a maximal rate can be achieved by adding exogenous agents, such as ascorbate or phenazine methosulfate, or endogenous cofactors, either combined as a "supernatant fraction" or as single purified components (flavins, heme proteins). The amounts of "supernatant factor" which produce the maximal photophosphorylation rate are equivalent to ascorbate at $2.2 \times 10^{-3} M$. This "ascorbate-equivalent" concentration for supernatant factor can be shifted to lower values when ascorbate is added together with flavins or the endogenous heme proteins (RHP or cytochrome c_2). Riboflavin and cytochrome c_2 evoke special responses which indicate that the cytochrome is the natural terminal electron acceptor in the oxidation system which supports photophosphorylation, while the flavin is active at the phosphorylation site as a cofactor for the endogenous pyridine nucleotide-linked flavoenzyme heme protein reductase. Further, it appears that a circular chain of respiratory catalysts located in the chromatophores couples photoactivated electron-transport to phosphorylation optimally at an effective intrachromatophore mid-point potential of 0.0 ± 0.01 volt.

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TAKEKAZU HORIO
Osaka University

Spectroscopic Investigation of Radiation from High Temperature Helium Plasmas at Pressures between 20 and 155 Atmospheres

The absolute radiative intensity distributions obtained from multipole electrical discharges in helium at pressures from 30 to 155 atm have been measured as a function of time and wavelength in the range from 3000 to 6000 A. The light pulses which exhibited a $1/e$ width of 2.7 μsec were produced by simultaneously discharging ten 0.1 μf capacitors charged up to breakdown voltage. Each capacitor was built into an individual discharge circuit of 1.34-Mcy/sec ringing frequency and approximately 0.1-ohm dissipative resistance. From the intensity measurements peak discharge temperatures were deduced. It was found that over the investigated pressure range, peak temperature and the square of the breakdown voltage—that is, the discharge energy—can be represented by a linear relationship at fixed electrode configuration. Peak temperatures were determined to vary, depending on pressure, between 42,000° and 63,000°K. Intensity distributions were observed to move towards limiting black-body intensities very rapidly with increasing pressures. At 155 atm, the highest pressure applied, intensities at no investigated wavelength were less than 0.45 black-body intensity. Because of electron densities of up to 9×10^{18} electrons/cm^3, considerable influences on the spectral energy distribution were observed. Electron densities were estimated from the measured broadening of the HeI line $2p^3P^\circ$–$3d^3D$ at $\lambda_0 = 5876$ A, and compared to those expected from the temperature measurements on the assumption of thermodynamic equilibrium. Agreement was found within the accuracy of the method. Measurements on the linear Stark-effect broadening of HeII, $n = 3 \leftrightarrow n = 4$, $\lambda_0 = 4686$ A are reported.

F. N. MASTRUP
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Correlation of Metabolism and Energetics in Contracting Muscle

While it is obvious that the energy for muscular activity originates in biochemical processes, it remains to be demonstrated that measurable manifestations can be quantitatively accounted for in terms of specific chemical reactions. A certain amount of progress has been made in studying this question for the anaerobic iodoacetate-poisoned frog sartorius muscle in which a breakdown of phosphocreatine occurs from the earliest moment of activity, and in which during, for example, 12 tetani of 400 msec at 0°C, this remains the only demonstrable metabolic reaction. So far, the following relationships have been established.

In isometric experiments, the course of phosphocreatine breakdown during a tetanus has been investigated (Marechal and Mommaerts, in preparation); this is more rapid at first than later, and the quantities correspond reasonably to the "labile" and the "stable" part of the maintenance heat as distinguished by Aubert.

When in isotonic contractions the amount of work is varied by changing the load (Mommaerts, Marechal, Seraydarian, *Biochim. et Biophys. Acta*, in press), there is a correlation between work performance and phosphocreatine breakdown such that there is an "activation metabolism" of 0.45 μmole/g per contraction, and a "work metabolism" of 1 μmole/9.1 mcal of work, equal to a reasonable estimate of the summated reaction heats under the circumstances. This constitutes a chemical identification of the Fenn effect. On the other hand, there is no correlation of metabolism with shortening; this is ascribed to the circumstance that, as the muscle shortens, the maintenance metabolism diminishes to an extent which approximately compensates for the shortening metabolism.

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Electron Transfer among Transition Elements, Sudden Transition to Covalency, and the Chemical Consequences, Particularly for Taube's Reaction

$CrCl_3$ will not dissolve in water unless Cr^{++} is present in solution. It is suggested that this is because $CrCl_3$ is covalently bonded and that Cr^{++} exchanges electrons with the surface atoms and this causes them to become ionically bonded and to dissolve, because Cr^{II} forms only ionic complexes and Cr^{III}, only covalent.

The sudden change in bond type from ionic for Cr^{II} to covalent for Cr^{III} applies also to Taube's reaction

$$Cr^{++} + (NH_3)_5Co^{III}L + 5H^+ = 5NH_4^+ + CrL^{III}$$

both for the oxidizing agent, Co^{III}, and for the reducing agent, Cr^{II}. The snapping of the Cr into a covalent state when the electron transfer occurs is possible only if acceptable groups are in positions ready to occupy the six octahedral positions, because of the Franck-Condon principle. This constitutes a barrier which appears to be rate-controlling for Taube's reaction, giving a high entropy of activation and a low heat of activation, as is observed. It also explains reasonably well the occurrence of hydrolysis of esters when used as ligands (L) and the relative magnitudes of the observed rates. It also explains why the alkyl esters hydrolyze with cleavage between the oxygen and alkyl group and explains a number of other details of Taube's reaction.

W. F. LIBBY
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Stability of Phonons in Bose Systems

Recent work on the quantum-mechanical many-body problem has shown that the low-lying excited states of a system are well described in terms of long-lived elementary excitations or quasi-particles. In most theoretical treatments these quasi-particles have a finite lifetime for decay even at absolute zero temperature, when collisions between quasi-particles are of negligible frequency. In liquid helium II, however, there appears to be an important difference. The energy-versus-momentum curve for the elementary excitations, as determined by slow neutron scattering, indicates that one phonon cannot decay into two or more phonons with conservation of energy and momentum. If we assume that the phonons are the only low-lying excitations of the system, we must conclude that the phonons are stable elementary excitations of the system.

In order to clarify the orgin of this difference, we have studied the low-density Bose system by the method of Bogolyubov and have found that the phonons are unstable for short-range interactions. The decay time at long wavelengths is calculated to be independent of the interatomic forces, in agreement with the published

result for hard-sphere interaction. The origin of this independence is suggested by an examination of the Hamiltonian formulation of quantum hydro-dynamics as given by Kronig and Thellung. The simple cubic term in the kinetic energy of the fluid is the dominant nonlinearity at low density and long wavelengths, and it gives a decay time in agreement with the value calculated by the Bogolyubov method.

This work was performed while I was a visiting research associate at the Instituut voor theoretische fysica der Rijksuniversiteit, Utrecht, Netherlands.

MARK NELKIN
General Dynamics/General Atomic, San Diego, California

Photosynthesis at Paired Wavelengths in Phycocyanin-Deficient Mutants of Cyanidium caldarium

Previous investigations of the monochromatic action spectrum for photosynthesis in *Cyanidium caldarium* demonstrated high photosynthetic activity at wavelengths (620 to 650 mμ) absorbed strongly by C-phycocyanin and low activity in spectral regions absorbed strongly by chlorophyll *a*. Present studies on the same strain, with paired wavelengths (far-red light paired with light of shorter wavelengths), reveal a typical Emerson enhancement effect, the action spectrum of enhancement corresponding to absorption by the C-phycocyanin.

In contrast with the wild type, ultraviolet mutants of *Cyanidium caldarium*, deficient in C-phycocyanin but possessing chlorophyll *a*, have photosynthetic action spectra which parallel closely the absorption of the latter pigment in the red portion of the spectrum. Low activity in the blue suggests absorption by photosynthetically inactive carotenoids. No enhancement of photosynthesis was observed in phycobilin-deficient mutants when a narrow band of far-red light (690 mμ) was paired with light of different shorter wavelengths. The implications of polychromatic enhancement in normal but not in phycocyanin-deficient strains of *Cyanidium* will be discussed.

KENNETH NICHOLS
Valparaiso University
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University of California, San Diego

Isolation and Properties of the Somatic Antigen of a Noncolicinogenic Variant of Escherichia coli K235

Colicine K is a bactericidal substance elaborated by *Escherichia coli* K235 and is an integral part of the O antigen of the bacillus. A mutant of the latter has been isolated which elaborates no colicine. We have undertaken to isolate the antigen of this bacillus and to compare its chemical and immunological properties with those of the parent. Any differences which these two substances might exhibit should be directly related to the antibacterial activity of the O antigen of the colicinogenic bacillus.

The antigen of the noncolicinogenic variant was isolated from the culture medium by alcohol precipitation and was further purified by ammonium sulfate fractionation. The antigen so obtained is electrophoretically homogeneous. Freshly prepared antigens form a single band in agar diffusion tests. Upon further purification, however, an additional weak band appears—a fact which suggests that the antigen is somewhat labile. The lipocarbohydrate component of the antigen, obtained by phenol dissociation of the latter, contains rhamnose, glucose, galactose, and a hexosamine. Agar diffusion experiments reveal that colicine K and the O antigen of the noncolicinogenic variant are serologically indistinguishable—a fact which indicates a very close chemical resemblance. The two substances must differ, however, for one is bactericidal and the other is not. Whatever this difference may be, it must be directly related to the antibacterial property of the colicine. A study of the protein components of the two O antigens has been initiated and should reveal differences in chemical structure which can be correlated with the antibacterial properties of colicine K.

ERWIN RUDE
WALTHER F. GOEBEL
Rockefeller Institute

Observations of the Pacific Pilot Whale, Globicephala scammoni, in Nature

The cetaceans, a group of mammals containing the whales and dolphins, are of much interest today because of the emerging realization that the group contains species of unusually high mental capacity. Yet consecutive observations of these animals in their natural habitat are rare because of the secretive habits of the component species and the vast extent of the oceans in which they live. Therefore, observations on the life history of a single species of small whale, the Pacific pilot whale, are of interest even though most are short observations of a fragmentary nature. During the years 1954–60, pursuit of this species for display purposes allowed observation of many facets of behavior. The observations to be reported range over the subjects of swimming speed, reproductive habits and cycles, diving abilities, and a variety of kinds of social behavior. Included in this latter category are observations on hunting school formations, feeding schools, and what are called "loafing groups," protective behavior in which school members assisted injured school-mates, maternal behavior in which mother whales supported the bodies of dead young, attempts to protect young from capture, and a specialized assisted locomotion which allows newborn young to stay in formation with fast-moving adult schools.

KENNETH S. NORRIS
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Nova (WZ) Sagittae as a Binary Star

In recent years a number of cataclysmic variables have been found to be binary stars. Among these are Nova (DQ) Herculis (1934), Nova T Coronae Borealis (1866, 1946), and probably all stars of type U Geminorum (dwarf novae). A spectroscopic survey for binary characteristics among novae is being carried out with the prime focus spectrograph of the 200-inch telescope. The spectrum of Nova (WZ) Sagittae (1913, 1946) indicates it is a single-line spectroscopic binary with the unusually short period of 80 minutes and a total velocity range of 1400 km/sec. The large velocity range suggests that eclipses are a definite possibility.

ROBERT P. KRAFT
Mount Wilson and Palomar Observatories

Melting of Some Pure Elements at High Pressures

The effect of pressure, to 50 kbar, on the melting point of a number of pure elements has been determined. Particular effort has been devoted to the alkali metals. In addition to the melting point curves, solid-solid transitions of pure elements have been determined to 50 kbar. Of interest is the behavior of cesium and cerium. Melting points of cesium rise to a maximum, and there appears to be a near continuum of the boundary between molten cesium and solid cesium which has undergone high-pressure electron-shell collapse. Thus, at higher pressures there may be a critical point between a solid and a liquid where melting phenomena take place with little or no volume or latent-heat discontinuities. A critical end point between two solids has been found in cerium, where close-packed cerium and cerium undergoing electron-shell collapse grade continuously into each other.

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R. NEWTON
A. JAYARAMAN
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Release of Tectonic Strain by Underground Nuclear Explosions

The strong excitation of SH waves and other phenomenology associated with underground nuclear explosions suggest the hypothesis that pre-existing tectonic strain was released by the explosion. The pertinent evidence from the Rainier explosion is reviewed. A calculation of tectonic energy release is made for a simple model in which a spherical cavity is inserted in a pre-strained medium. It is tentatively concluded that, although tectonic release does occur, its magnitude is probably too small to affect the character of seismograms. Experiments are suggested which could provide the basis for a better evaluation of the hypothesis.

FRANK PRESS
CHARLES ARCHAMBEAU
California Institute of Technology

Diurnal Variation of K Indices of Geomagnetic Activity on Disturbed Days

In studying the diurnal variation of the K indices of geomagnetic activity from six observatories in moderately low latitudes and fairly evenly distributed in longitude, a local-time component showing a change of the yearly average over the 18 years 1940–57 has been found in the data for the 5 disturbed days of each month. These years cover nearly two sunspot cycles, and the change is similar for the two cycles. A change of the same general kind was found for the 10 quiet days of each month for the 9 years 1940–48. The change is such as might be occasioned by an increase or decrease in activity during the day, relative to that during the night, that accompanies in general an increase or decrease in the yearly average sunspot number with the cycle.

SETH B. NICHOLSON
Mount Wilson and Palomar Observatories
OLIVER R. WULF
U.S. Weather Bureau,
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Unusual Nucleic Acid Fraction from Neurospora crassa

An investigation of the distribution of nucleic acids in subcellular fractions of *Neurospora crassa* led to the isolation of a particulate component rich in RNA and containing a trace amount of DNA. The DNA content of this fraction is highest in actively growing young hyphae.

Deoxycholate treatment of these particles solubilizes all the DNA and a small amount of the RNA, leaving the bulk of the RNA and protein sedimentable. Phosphorus-32 incorporation studies indicate that the deoxycholate solubilized RNA is newly synthesized. Experiments employing chromatography with ECTEOLA, thermal denaturation, and nuclease digestion suggest that the deoxycholate-solubilized fraction contains a specific complex of DNA and RNA.

The possible role of this complex as an intermediate in the expression of genetic information will be discussed.

HERBERT M. SCHULMAN
University of California, San Diego

Rate of a Hapten-Antibody Reaction

The rate of the bimolecular reaction of a hapten and its specific antibody has heretofore not been measured directly. In these experiments, a purified rabbit antibody (generously donated by H. N. Eisen), specific for the 2,4-dinitrophenyl determinant, was reacted with the hapten 2-(2,4-dinitrophenylazo)-1-naphthol-3,6-disulfonic acid, disodium salt. A marked shift in the absorption maximum of the azo dye, from 580 to 485 mμ, occurs on binding to specific antibody near *p*H 7. This spectral change is due to a *pK* shift of the naphtholic OH group of the bound dye, and a consequent protonation of this group on binding. This spectral property permitted a rate study of the hapten-antibody reaction to be made with a stopped-flow spectrophotometric instrument.

The assumption is made that the protonation of the dye is not rate-limiting. At an antibody concentration of $2.7 \times 10^{-6} M$ (antibody is bivalent and has a molecular weight of 1.6×10^5) and a hapten concentration of $2.0 \times 10^{-6} M$ in a buffer containing $0.02M$ phosphate and $0.15M$ NaCl, *p*H 7.4, at 25°C, the reaction was 57 percent completed within the dead time of the instrument, 0.004 second. Thereafter, the reaction followed second-order kinetics, with an apparent specific rate constant $k = 1 \times 10^6$ l mole^{-1} sec^{-1}. If the initial 57 percent of the reaction is assumed also to have followed second-order kinetics, its average k was 1×10^8 l mole^{-1} sec^{-1}. This distribution of k values possibly reflects heterogeneity in the antibody binding sites.

From measurements at 12.7°, 25.0°, and 40.0°C, an apparent activation energy of 6 kcal/mole was obtained, either from the more rapid initial parts or from the slower, directly measured parts of the reaction.

The extraordinary rapidity of this reaction (among the most rapid bimolecular reactions known) and its small activation energy indicate that little or no conformational rearrangements are required within the active sites of the antibody molecules on specific binding of the hapten.

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Travel Time for Light from Distant Galaxies Related to the Riemannian Curvature of the Universe

Two methods can be used to determine the radius of curvature of the universe. (i) In principle, galaxy counts determine the deviation of spatial volumes from $4/3\pi r^3$. However it can be shown that this method is insensitive even at the limit of the 200-inch telescope. (ii) Einstein's gravitational equations give the spatial curvature once the mean density of matter and radiation is known. This density can be found in principle from observations of the deceleration of the expansion of the universe. The deceleration can be found by comparing red-shift observations of nearby and very distant galaxies. The information is contained in the deviation from linearity of the red-shift, apparent magnitude relation for the galaxies, but unfortunately, an uncertain correction must be applied to the magnitude data before the deceleration can be found. Light from the galaxies now observed at the limit of the 200-inch with red shifts of $\Delta\lambda/\lambda_0 = 0.50$ started the journey toward the earth 4.1×10^9 years ago (if $H_0^{-1} = 13 \times 10^9$ years). We observe the properties of these galaxies as they were at this early time. Undoubtedly the stellar content of the galaxies has evolved in this immense time interval, and a change of brightness has occurred.

Exact calculations of the light travel time for galaxies of given red shifts are shown. A preliminary estimate of the evolutionary change of brightness of galaxies in this time is given, and the *very tentative* conclusions are reached that the deceleration parameter is $q_0 = +0.2$; that the universe is open and infinite, with a non-Euclidean hyperbolic geometry; that the radius of curvature is 17×10^9 light years (1.6×10^{29} cm); that the mean density of matter plus energy is 4×10^{-30} g/cm^3; and that the expansion will continue forever.

ALLAN SANDAGE
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Function of the Golgi Apparatus in the Exocrine Pancreas Cell

The various stages of the secretory cycle have been studied in the exocrine pancreas cell by making use of a clear-cut temporal sequence of these stages during embryonic development of the pancreas. The Golgi apparatus manufactures membrane material forming the surface membrane of precursor granules that develop into zymogen granules. The precursor granules show low opacity corresponding to a low concentration of solids. They move out from the Golgi apparatus, and then the secretory products are gradually concentrated in the granules. The membrane, therefore, is involved in this process of concentration and can be considered active membrane concentrating against a steep concentration gradient. The possibility of its contributing to the synthesis or chemical modification of the secretory products should be explored. This concentration takes place outside the Golgi region. Therefore, the Golgi region appears as a site of manufacture of the membrane but not as the actual site of the concentration of the secretory products.

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Does the Earth's Inner Core Behave as a Foucault Pendulum?

The lowest frequency peak (period 86 min) in the spectral analysis of gravimeter observations of the Chilean earthquake of 22 May 1961 has been ascribed to a rigid-body sloshing movement of the earth's solid inner core in its fluid surroundings. Initially the direction of such displacements would evidently be from the epicenter (latitude 38°S, longitude 73½°W) toward the earth's center. The gravimeter (located at 34°N, 118°W) is responsive only to the component of the core displacement along the vertical at the gravimeter. Because of the fluidity of the outer core it is suggested that the solid inner core is decoupled from the rotating earth so that it vibrates in a fixed plane (or at least in a plane rotating only slowly) like the classical Foucault pendulum. If so, the excitation of the gravimeter would be

relatively high during about half the day and low during the remaining portion. For the specified geometry, the mean square value of the excitation for the favorable interval is 13-fold greater than that for the succeeding unfavorable interval. The original observational data were taken at 1-minute intervals for a period of 4½ days following the earthquake. These data were regrouped to form a time series composed only of favorable intervals and one composed only of unfavorable intervals. These series were each analyzed spectrally in accordance with previously described techniques. In these two analyses, the amplitudes of all peaks except that associated with the supposed Foucault pendulum mode of the inner core should remain in constant ratio, but the amplitude of the latter should be much enhanced during the favorable period. The results and significance of these analyses will be discussed.

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Mode Conversion and Dissipation of the Earth's Free Oscillations

The fundamental spheroidal mode of the earth was excited by the Chilean earthquake of 1960. Spectral analysis of strain recordings shows that this mode is split, and at least four of the five possible lines can be observed. The average spacing of these lines is in good agreement with the expected effect of the rotation of the earth. The intensity of these lines has been studied as a function of time in an attempt to measure the dissipation function of the earth. The two most intense lines, corresponding to surface harmonics $P_2^{-1}(\cos\theta)\exp(-i\phi)$ and $P_2^{1}(\cos\phi)\exp(i\theta)$, have apparent rates of decay that are significantly different. The weak central line corresponding to the zonal harmonic $P_2(\cos\theta)$ actually shows a steady increase in intensity with time over a 20-day interval following the earthquake.

In view of these facts, we believe that the apparent rates of decay are controlled by the transfer of energy between adjacent spectral lines. Furthermore, the data indicate that energy is transferred from the tesseral harmonic modes to the zonal mode.

These results are based on a single example of the excitation of the earth's free oscillations.

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Terrestrial Age of Stony Meteorites

It is generally assumed that stony meteorites are subject to weathering and disintegration in a relatively short time after fall. Cosmic-ray-produced radioactivities provide a possible means of determining the time elapsed since a meteorite fell. Radiocarbon proves to be a useful isotope for this purpose. We have measured the radiocarbon content in five meteorites that have fallen during the past few decades. This content shows variations of less than 20 percent. In the case of finds of unknown time of fall, however, the radiocarbon content was found to be much smaller. The terrestrial age calculated from these measurements on stony meteorites ranges from a few thousand years to more than 20,000 years, the limit of the method. This means that stony meteorites are preserved longer on the surface of the earth than we had anticipated.

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Isotopic Composition of Barium and Cerium in Stone Meteorites

Reynolds observed that in addition to the special anomaly due to the decay of I^{129} to Xe^{129} there was a more general anomaly in the abundances of the isotopes of xenon. This suggested that other variations of this kind might possibly be observed. Barium is near xenon in the periodic system, has a similar range of isotopes in mass numbers, and thus might show anomalies of this kind. An investigation of three meteorites showed variations in the isotopic abundances relative to terrestrial samples. This appears to indicate a very substantial synthesis of elements during the formation of the solar system, or a lack of complete mixing of previous synthetic products during the formation of the solar system.

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Impulse Traffic in the Optic Nerve of Decapod Crustacea

Single unit recording from axons in the "optic nerve" of the crab, *Podophthalmus vigil* (Fabricius), has shown that a large proportion of these axons are essentially interneurons of the central nervous system, carrying information to as well as from the optic ganglia in roughly equal numbers. This finding confirmed and extended previous preliminary experiments on a variety of decapods (Waterman and Wiersma, in preparation). From the eye, integrated information is carried by a variety of fiber types, distinguished according to (i) the area of the visual field to which the fiber responds, ranging from the whole eye down to fairly small areas; (ii) the type of stimulation eliciting maximal responses, ranging from fast-moving large objects to changes in the intensity of stationary illumination; (iii) the amount of contrast necessary for maximal stimulation; and various other factors, all of which combine to give each interneuron specific properties.

Fibers carrying information to the eye respond to (i) visual stimulation of the heterolateral eye, many with characteristics similar to those outlined above; (ii) hair and/or joint stimulation of different parts and extents of the body; and (iii) visual as well as tactile and proprioceptive stimulation, in various combinations. The optic nerve of Decapoda must hence be considered a connective between parts of the brain. Since animals in which both eyes are cut off still respond to nonvisual inputs, information of which is normally transmitted by interneurons toward the eyes, it is evident that this information is integrated in the brain as well as in the optic ganglia. It is therefore strongly indicated that, at least in the crustacean central nervous system (CNS), not only is the sensory input subjected to simultaneous parallel analysis, by different interneurons, as has been shown previously (Wiersma, 1958), but also parallel integration of this already analyzed information takes place, in different parts of the CNS. This would provide for functional integrity even when large parts of the CNS are not able to function for one reason or another.

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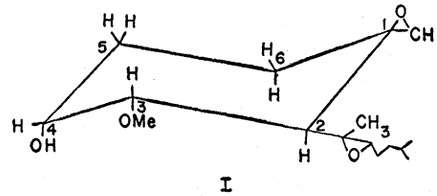
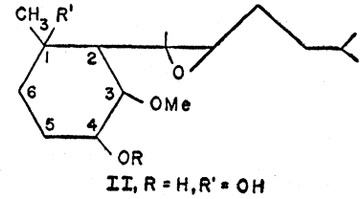
Stereochemistry of Fumagillin

Dihydroalcohol-I (structure I) is obtained from fumagillin by hydrolysis and reduction [D. S. Tarbell *et al.*, *J. Am. Chem. Soc.* **82**, 1005 (1960)] (Fig. 1). By assigning the seven-carbon side chain at carbon-2 to the equatorial position, it is possible to deduce the stereochemistry of the cyclohexane ring in I; the results are in agreement with those obtained by McCorkindale and Sime (*Proc. Chem. Soc.*, in press) from x-ray analysis. Reduction of I yields the tetrahydroalcohol (structure II), and dehydration of the latter (II, $R = COCH_3$) with thionyl chloride-pyridine gives two isomeric anhydro derivatives, with an exocyclic methylene and a 1,6-double bond, respectively. Oxidation of the 1,6-isomer gives the 1,6-epoxide, and this is converted by hydride reduction to the tetrahydroalcohol (II). The hydroxyl at position 1 is therefore axial, and hence



I



II, R = H, R' = OH
III, R = R' = H

Fig. 1.

the oxygen of the spiroepoxide in I must be axial. Deoxytetrahydroalcohol (structure III) may be prepared from both anhydro derivatives by reduction. Treatment of III with phosphorus oxychloride-pyridine eliminates the 4-hydroxyl, with formation of a 3,4-double bond. A trans diaxial elimination may be assumed, and hence the 4-hydroxyl and the 3-hydrogen are axial; the 3-methoxyl is therefore equatorial. Dihydroalcohol (I) has the same configuration as III at positions 2, 3, and 4, and therefore the stereochemistry of I is as represented. The stereochemistry of cyclizations of derivatives of II and III, and of model compounds, to perhydrobenzofurans, with loss of methoxyl [D. S. Tarbell *et al., J. Am. Chem. Soc.* **82**, 1005 (1960); *ibid.*, in press], will be considered.

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Evidence for Convection in the Earth's Crust and Upper Mantle

A world-wide network of rifts characterized by concentration of earthquake epicenters and low seismic speeds for the mantle material has been proposed by several investigators to account for tectogenesis and continental drift. These features presumably mark the location of upwelling hot mantle material, which then spreads laterally, causing great horizontal displacements of the crust. When such an upwelling current happens to be under the ocean, it generates a broad topographic rise with high heat flow along its crest. When it happens to come under a continent, rifting of the land mass occurs, with outflow of lava and thinning of the crust.

These concepts are applied to the East Pacific Rise. Its oceanic portion has been investigated seismically, geothermally, and topographically. Where it plunges under North America, it caused rifting of the Gulf of California, recent volcanism of the Basin and Range Province, and great lateral east-west displacements in the ocean floor along the Mendocino and Murray faults. The upper mantle and crust moved westward by the addition to the ocean floor of strips of sima several hundred miles long, which show up as north-south magnetic anomalies between latitudes 25° to 50° N and extend from the continental slope to 150° west longitude. The western edge of the upwelling mantle current is defined by heat-flow measurements at sea. The eastern edge lies probably at the Rocky Mountain Front, as suggested by the change in character of magnetic time variations, which indicate shallow depth to electrically conducting, and therefore hot, material between Yuma, Arizona, and Las Cruces, New Mexico. Additional experimental evidence to test this hypothesis can be obtained by measuring geothermal heat flow west of the Rio Grande Valley and by simultaneously recording three components of magnetic time variations on the ocean floor at several stations along lines crossing the East Pacific Rise.

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Meteoritic and Terrestrial Abundances of the 14 Rare-Earth Elements, Lanthanum to Lutetium

Accurate abundance values for the 14 rare-earth elements, lanthanum to lutetium, are necessary in order to establish empirical relationships among the abundances of the chemical elements formed in nucleosynthesis. Because of the high degree of chemical similarity of the rare earths, these elements are assumed to have migrated through time and space as an entity.

By using the highly sensitive technique of neutron activation analysis, the concentrations of these elements have been determined in two chondritic stones, two achondritic stones, two iron meteorites, and a fresh basalt sample from the Kilauea volcano in Hawaii. After a 2-hour irradiation in a Triga reactor at a flux of 1.8×10^{12} neutrons/cm^2/sec, the 5-g meteoritic or basaltic samples were subjected to radiochemical and ion-exchange techniques in order to decontaminate and to separate individually the 14 elements.

Some of the observations from this study are noted. (i) The abundances of the odd- and even-A atomic masses in the stone meteorites decrease rather smoothly and with nearly identical slopes for increasing A. (ii) Abundances of the even-A masses are about 4 times greater than the adjacent odd-A masses. (iii) Absoute abundances in achondritic meteorites were about 10 times greater than in chondritic meteorites. (iv) The ratio of concentrations in the iron to that in stony meteorites was about 10^{-4}. (v) Isotopic ratios of five of the elements in these meteorites agree with terrestrial values. (vi) Relative concentrations in the Kilauea basalt agree well with relative contents in other terrestrial matter.

Implications of these findings will be discussed.

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Double Visual Learning in Split-Brain Monkeys

The demonstrated ability of split-brain monkeys to perform mutually contradictory visual discriminations raised the question of whether these conflicting processes might be carried on simultaneously, in parallel, in the separated hemispheres. To test this, an apparatus was designed that employs polarized light filtration to make the two eyes see different things at the same point in space. It enables one to present the subject with different, even contradictory, tasks simultaneously, one visible to each eye, and to test thereby the functional independence of the two separated hemispheres. This double learning technique has also proved useful in further analysis of the neural mechanisms of visual perception.

A study with simultaneously presented contradictory tasks has shown that the surgically separated brain halves may learn side by side at the normal rate, as if they were quite independent. But there are more occasions when one hemisphere learns normally while the other is slower or fails to learn. Competition between the two halves of the brain appears to take place nearer the motor level of integration. Frequently there is a preferential contralateral coupling, such that eye and limb centers are in the same half of the brain, the right eye learning when the left hand is active and vice versa. Tests, in which the experimenter has full control over eye-hand combinations which the subject is allowed to use, show that ipsilateral eye-hand pairs may become efficient at learning and recall of visuomotor tasks. This occurs even though, under the experimental conditions, the main motor centers for the limb involved are in the opposite hemisphere and are surgically separated at all higher levels from the centers receiving the visual information.

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Bristle Pattern of Drosophila

The bristle pattern of *Drosophila* may be estimated to have been present—probably originally with more bristles than are now found—for at least 10^8 generations. Natural selection has evidently stabilized this pattern, which is now remarkably constant in wild-type flies—that is, it is modified only slightly or not at all by environmental influences.

Various mutant genes are known which remove certain bristles or add new ones, usually, at least, ones that are known in related Diptera and that may be supposed to have been present in the ancient ancestral pattern. These new patterns, caused by mutant genes, are regularly quite variable, in response both to modifying genes and to such environmental influences as nutrition and temperature.

There is little obvious regularity about the reduced patterns due to different mutant genes. The two dorsocentrals are usually unaffected or both affected, as are two scutellars and the two anterior orbitals. Otherwise no rules of general applicability appear. A study has now been completed that indicates the same conclusion for modifying genes. Each bristle (or each pair in the cases of the dorsocentrals, the scutellars, and the two anterior orbitals) has its own set of controlling genes. The members of such sets may affect other bristles, but there are no clear rules as to which others are likely to be affected by any such gene.

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Termination of Immunological Tolerance to a Protein Antigen

Immunological tolerance produced by injection of neonatal rabbits with bovine serum albumin (BSA) was lost following injection of the tolerant rabbits with certain serologically related albumins. The more distantly related the albumin was, the greater was its ability to break the tolerant state. Also, the breaking of the tol-

erant state was inhibited if soluble BSA was injected with the related albumin. The injection of the related albumin in the form of Freund's adjuvant was less effective than the injection of soluble albumin. Injection of acetylated, heat-denatured, picrylated, and pepsin-treated BSA not only failed to break the tolerant state but also failed to elicit antibody to the altered portion of the molecule.

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Further Studies in Learning with "Split Brain" Cats

Cats have been trained to perform a conditioned response (flexion of forepaw to flashing light) the primary motor control of which is on the left side of the brain, while sensory input has been restricted to the right side. Midline section of neural cross connections was performed in progressive stages. The most complete bisection to date includes division of optic chiasm; corpus callosum; anterior, posterior, habenular, hippocampal, and tectal commissures; mass intermedia; and the tegmentum through the rostral third of the pons. The conditioned response survived these procedures and was also established in naive animals after surgery.

Removal of visual and motor cortices and other structures suspected of playing a critical role in conditioning have been combined with the afore-mentioned procedures. Results at present indicate that the conditioning process may entail development of central, cortically organized facilitatory sets rather than formation of new connections between cortical receptor and motor centers, as has been classically postulated.

Related experiments have been carried out on cats to determine the role of midline structures in the performance of perceptual brightness and pattern discriminations. The two visual stimuli to be discriminated were projected, one to the right hemisphere and the other to the left hemisphere, by using colored light sources and training goggles with color filters on animals with the optic chiasm sectioned. Brightness discriminations under these conditions survive midline section of corpus callosum and of anterior, posterior, habenular, hippocampal, and tectal commissures, indicating that for brightness perception at least, the tegmentum may play a critical role. Pattern discriminations are presently being run in a similar manner.

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Organic Matter in the Atmosphere as Energy Supply for Lightning

All plants continuously produce small amounts of volatile organic matter, such as terpenes and esters, which become polymerized in the air under the influence of sunlight and then, as polymers, are very stable against further decomposition. It was suggested that these materials not only are the source of atmospheric hazes but also form the parent material for petroleum formation. A major difficulty with this hypothesis is that there should be much more oil and asphalt in the crust of the earth than there is. It is now suggested that this organic matter in the atmosphere can decompose with the formation of positive charges, giving rise to the fair-weather current in the atmosphere and to the high voltages generated in thunderclouds. Most of this positive charge is concentrated in the surface of the cloud, where also most of the organic matter accumulates. When the total energy available in this volatile plant material is calculated, it is found to agree very closely with the total energy in all lightning bolts. The distribution of thunderstorms also closely parallels the density and activity of the vegetation: most thunderstorms occur in the tropics and, during the summer months, in temperate regions, whereas the oceans, deserts, and polar regions are practically free of them. It is suggested that this organic matter, when it accumulates further, can be the source of energy for tornadoes.

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Missouri Botanical Garden

Symposium on Particles and Fields in Space

Gordon J. F. MacDonald, Chairman

Spectrum of Hydromagnetic Waves in the Exosphere

Three wave fronts, propagating vorticity about the line of force, two-dimensional divergence transverse to the line of force and the longitudinal component of velocity carry a hydromagnetic disturbance through a uniform electrically conducting fluid in a magnetic field. The propagation of vorticity is one-dimensional, and there is no geometrical attenuation. It is suggested that this mode predominates in transferring magnetic storm energy. The propagation of the longitudinal component velocity is almost one-dimensional but is heavily damped at high frequencies. In a gravitational field, the medium is no longer uniform, and at low frequencies the modes are coupled in a complicated way. The influence of gravity is characterized by the frequency of oscillation of a small parcel of fluid when displaced from its zero-order position in the gravitational field. For parallel magnetic and gravitational fields the vorticity mode is still separable, and gravity leads to anisotropic dispersion in the other modes. The propagation at low frequencies is no longer cylindrically symmetrical if the lines of force are at an arbitrary angle to the direction of gravity. Detailed investigations of the influence of the gravitational field on hydromagnetic wave propagation is carried out for the case where the sound velocity is small as compared to the Alfvén wave velocity.

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Effect of Hydromagnetic Waves on the Lifetime of Van Allen Radiation Protons

The effect of hydromagnetic waves upon the motion of charged particles trapped in the geomagnetic field is studied. Application is made to the proton component of the Van Allen radiation belt. It is shown, in agreement with the suggestion of Welch and Whitaker, that hydromagnetic waves of low frequency and amplitude are able to account for the rapid decrease in proton flux that delimits the outer edge of the inner zone of the Van Allen radiation belt. Both the location of the boundary of the inner zone and the ratio between the proton fluxes in the inner and outer zones are obtained. It is found that near 2 earth radii from the earth's center, the maximum energy of the trapped protons decreases with geocentric distance as r^{-11}.

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Elementary Collision Processes in the High Atmosphere

Many high-atmosphere phenomena—for example, the collision electron density in the E layer—depend on collision rates which are not readily measurable in the laboratory. This paper lists a number of such collision processes and briefly reviews the presently available theoretical procedures for estimating their rates.

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