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Obscurations of Lunar Features

During the past couple of centuries many unverified reports of lunar haze have been published by amateurs, many of whom were experienced observers. Most discussed were the floor of Plato and the bright mound, Linne. A Lick Observatory photograph (26 Oct. 1937) showed the floors of Ptolemaeus, Alphonsus, and Flamarion as "milky." This may have been only photographic illusion. Because of these reports a program was planned to secure pairs of plates at widely different wavelengths by means of the 60-inch reflector at Mt. Wilson.

Such observations have been carried on since April 1954. On 26 Oct. 1956 rather strong positive evidence was secured within Alphonsus. As a result, N. A. Kozyrev, at the Crimean Observatory, made systematic spectrographic observations and on 3 Nov. 1958 secured the strongest positive evidence to date. An interpretation of his results is included in this paper. Systematic observations of all suspicious areas of the moon must be carried out, all known methods being used to secure them.

DINSMORE ALTER
Griffith Observatory and Aeronautics Systems

Solution of the Main Problem of Artificial Satellite Theory

The principal part of the motion of the argument of the perigee of an artificial satellite contains the factor $-1+5\cos^2 I$, I being the inclination of the satellite's orbital plane with the earth's equator. This factor again appears as a divisor in the coefficients of certain periodic terms. This divisor is zero for the critical inclination, $I_c = 63°26'$; hence, this type of representation of the motion becomes illusory for orbits with inclinations within a few degrees of the critical inclination.

The difficulty is overcome by making use of a method in canonical variables that is equivalent to the method used by Delaunay in the lunar theory. Actually, the procedure is similar to that employed by H. v. Zeipel (*Arkiv. Mat. Astron. Fysik* **11**, 1, 1916) in a qualitative study of planetary perturbation theory. The core of the method is choosing a transformation of variables such that the argument of the perigee is the only angular variable present in the transformed Hamiltonian. The system is thereby reduced to 1 degree of freedom; it can be solved completely by well-known procedures.

A significant feature of the method is that, to the degree of accuracy required for current practical needs, the solution is achieved in closed form, valid for any eccentricity of less than unity and for any inclination.

DIRK BROUWER
Yale University Observatory

Morphologic and Metabolic Changes Produced in Rat Adipose Tissue in Vitro by Insulin

Addition of insulin to the rat epididymal fat pad incubated in vitro in bicarbonate-buffered media markedly stimulates the uptake of glucose and its conversion to fat. This effect is readily observed by measuring manometrically the increased CO_2 output that accompanies fat synthesis. Using this procedure to monitor the effect, we made preliminary studies with the electron microscope of the accompanying morphologic changes at different insulin and glucose concentrations and with different incubation periods.

For example, 20 minutes after the addition of insulin (10^{-3} units per milliliter), a definite metabolic change has occurred, and tissue taken for examination at this time shows characteristic morphologic changes. Whereas control tissue incubated without insulin showed a rather dense granular cytoplasm in which the population of organelles was sparse, the cytoplasm of tissue incubated with insulin showed a loss of granularity in the cytoplasm and the development of a system of membrane-bound vesicles that, at the plasma membrane, appeared as pinocytotic invagination and pinched-off vesicles. Deeper in the cytoplasm a seemingly continuous system of smooth, large-membrane–bounded vesicles or canalicular channels had developed. Lipide droplets were present in the cytoplasm. Although minute pinocytotic vesicles were occasionally found bordering the plasma membrane of tissue incubated without insulin, no membranous systems of vesicles or channels were found.

We tentatively suggest that one of the actions of insulin is to stimulate pinocytosis, which brings about the described morphologic changes, and that as a consequence, alterations in the properties of the membrane occur which make it more permeable to certain molecules—for example, glucose. Such a concept of insulin action receives support from the rapid fixation of insulin to tissue first observed by Stadie *et al.*, and from the experiments of Levine, Park, and others on the effect of insulin on cell permeability.

RUSSELL J. BARRNETT, ERIC G. BALL
Harvard Medical School

Vacuum Polarization and Screening Effects in Scattering from Heavy Nuclei

In order to facilitate geometry calibrations of proton-proton scattering experiments by scattering of protons by nuclei and as a matter of general interest, effects of the vacuum polarization have been calculated and compared with screening by electrons. In Uehling's approximation the vacuum polarization appears as a superposition of Yukawa terms for which the scattering amplitude is expressible by means of the hypergeometric function suitable for computation and can be rearranged in series with Bessel functions of imaginary argument $K_n(x)$ in coefficients of incident momentum. This expansion is related to the classical orbit view shown to furnish a fair approximation.

Classically, the quantity x is the eccentricity of the orbit times half the minimum distance of closest approach times the reciprocal range constant of the potential. The vacuum polarization scattering is obtained by superposing amplitudes for Yukawa potentials. The results can be represented approximately by a universal curve relating $z_1 z_2/[E_{lab} \sin(\theta/2)]$, in usual notation, to the fractional change in the differential cross section. For $\theta = 10°$ and energies 3 and 1.5 Mev, proton-argon scattering effects of 0.272 and 0.116 percent, respectively, and for alpha-lead scattering at $\theta = 5°$ and 21.95 Mev, a vacuum polarization effect of 0.080 percent, are found. In the latter case the screening effect is -0.6 percent. For proton-xenon, 9 Mev, 10°, the screening effect is -0.28 percent, comparable with the vacuum polarization effect. Precision tests of vacuum polarization action for fundamental theory are complicated by the presence of screening potential.

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G. BREIT, S. OHNUMA
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A Long-lived Carbonium Ion Intermediate in a Molecular Rearrangement

On the basis of evidence which is extensive and consistent but indirect, numerous molecular rearrangements have long been known to proceed by way of

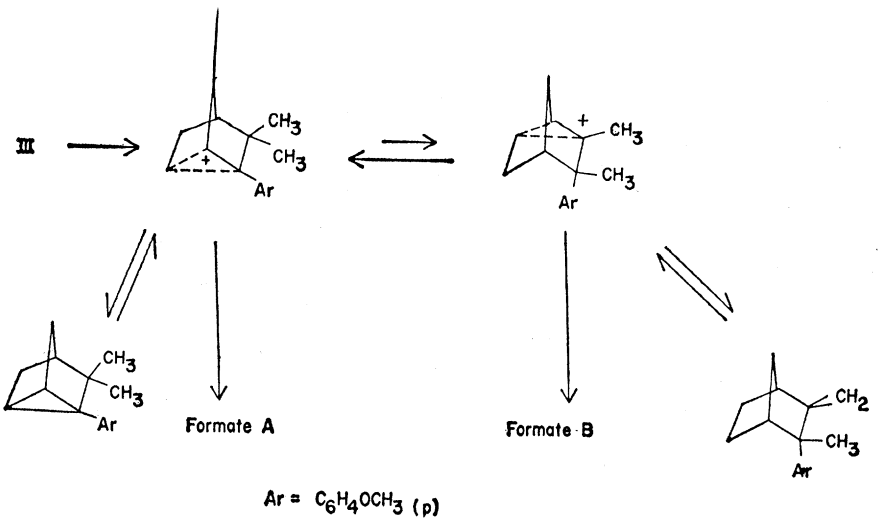
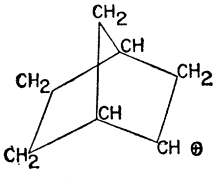
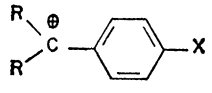


Fig. 1

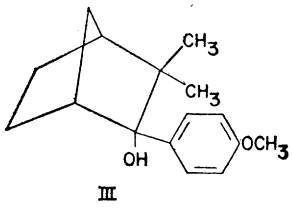
carbonium ions (molecular species bearing a positive charge on a carbon atom or distributed over a group of carbon atoms). There are several structural features which enhance the stability of carbonium ions, among them the occurrence of the charge at the 2-position of a bicycloheptane ring (I) or in the alpha position of a side chain attached to a benzene nucleus (II).



I



II



III

In *p*-anisylcamphenilol (III) the hydroxyl group is at the 2-position of a bicycloheptane ring and is also in the alpha position of a substituted benzene containing the activating methoxy group. This compound dissolves in formic and hydrochloric as well as in sulfuric acid with the formation of electrically conducting solutions with intense absorption in the near ultraviolet ($\gamma_{max} = 384$ mμ, log $\varepsilon = 4.7$). These solutions yield a series of products of the sort commonly produced in the Wagner-Meerwein rearrangement. Kinetic analysis of the rate of decline of optical absorption or of conductivity in formic acid leads to the description of the initial reactions shown schematically (Fig. 1).

Optically active starting materials yield a series of products whose optical activity rules out the occurrence of symmetrical intermediates and indicates a series of extensive changes on prolonged standing of the solutions.

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Wellesley College
CHARLES E. DILLS
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Yale University

Effect of Spin and Speed on the Lateral Deflection of a Baseball; Magnus Effect for Smooth Spheres

The effect of spin and speed on the lateral deflection (curve) of a baseball has been measured by dropping the ball while spinning about a vertical axis through the horizontal wind stream of a 6-foot tunnel. For speeds up to 150 ft/sec and spins up to 1800 rev/min, the lateral deflection was found to be proportional to the spin and to the square of the wind speed. When applied to a pitched ball in play, the *maximum* expected curvature ranges from 10 to 17 in., depending on the spin.

The deflections of rough baseballs accord in direction with that predicted by the Magnus effect. But with *smooth* balls at low speeds the deflection is in the *opposite* direction. This is studied with an apparatus specially designed to measure the pressure at any point in the equatorial plane of the rotating ball.

LYMAN J. BRIGGS
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Ionic Membrane Current Measurements in the Squid Giant Axon

The measurement of the ionic current flow across the squid axon membrane in a "voltage clamp" has the two requirements that the membrane potential difference be uniform over the membrane area through which the current is measured and that it be constant for the duration of the current measurement after the change from the initial resting potential. These requirements prevent impulse propagation or initiation and are approached with low-resistance axial and external electrodes and powerful electronic control.

It has been found that the best axons, in condition to give their maximum responses and when the membrane potential is well controlled, usually produce ion current patterns that are of the type originally described by Cole and analyzed by Hodgkin and Huxley, though several times larger than these. The surface resistance of the axial electrode was found to be the most critical single factor, and the occasional obvious distortions of the current patterns are attributed to the marginal adequacy of this and the external electrodes. For axial electrode resistances but a few times larger than the best so far used, the membrane potential has been found not only to be inadequately controlled but also to behave in a manner that can be predicted by approximations of the Hodgkin and Huxley equations.

K. S. COLE, J. W. MOORE,
R. E. TAYLOR
National Institutes of Health

Dependence of the Walden Product on Dielectric Constant

Analysis of conductance data for the following nine systems—(i) tetrabutylammonium bromide in dioxane-water mixtures, (ii) in methanol-carbon tetrachloride mixtures, and (iii) in nitrobenzene-carbon tetrachloride mixtures; (iv) tetrabutylammonium tetraphenylboride in acetonitrile-carbon tetrachloride mixtures and (v) in nitrobenzene-carbon tetrachloride mixtures; (vi) tetraethylammonium picrate in water-methanol mixtures; and tetrabutylammonium (vii) iodide, (viii) nitrate, and (ix) picrate in nitrobenzene-carbon tetrachloride mixtures—shows that the Walden product (limiting equivalent conductance times viscosity) varies in a systematic way with solvent composition. The effect is shown to be electrostatic in origin: A one-to-one correlation exists between the Walden product and the dielectric constant D of the solvent, regardless of the nature of the dependence of viscosity on composition (increasing, decreasing, and so on).

On the assumption that the transference members of both ions in tetrabutylammonium tetraphenylboride are equal, it is possible to calculate single-ion conductances for systems (iii), (iv), (v), (vii), (viii), and (ix); single-ion conductances are known for bromide ion in water and in methanol. From the single-ion conductance λ, the Stokes radius $R = 0.8194 \times 10^{-8}/\lambda\eta$ is obtained; a plot of R D against D is linear, showing that R has the form $R = R_\infty + A/D$, where R_∞ is the hydrodynamic radius in a hypothetical solvent of infinite dielectric constant.

The dependence is ascribed to an electrostatic braking mechanism: As an ion

moves through a solvent, it must orient solvent dipoles in front of it and allow to relax to random orientation those behind it. Since the solvent has nonzero viscosity, a steady state will be set up in which the distribution of dipoles around the moving ion will lag behind the equilibrium distribution around a stationary ion, and hence the ion in effect carries with itself a field which opposes the external field. Correlations have been found between the constants R_∞ and A and the structure of solute and solvent.

RAYMOND M. FUOSS
Yale University

Chromatic Transients in the Photosynthesis of a Green Alga

Temporary alterations in the photosynthetic rate of red algae on alternating exposures to monochromatic red and green light (without intervening dark periods) have been previously described. These have now been found in the marine green algae, *Ulva lobata* and *Ulva taeniata*. Measurements of oxygen production were made by means of a polarized platinum electrode in direct contact with the tissue, giving a very rapid time response. In *Ulva*, on passing from a region of chlorophyll absorption (540 mμ) to one of predominant carotenoid absorption (490 mμ), a quick increase (cusp) of oxygen production occurred, followed by a depression and then by a slower recovery to a steady state equal to the previous 540 mμ level. Reillumination at 540 mμ produced a depression followed by recovery. These changes amount to some 10 or 15 percent of the total photosynthesis. Similar transients are found on passing directly from light absorbed by chlorophyll-α (688 mμ) to that mostly absorbed by chlorophyll-β (640 mμ).

It is suggested that the effect is due to enhanced respiration at 490 mμ (and 640 mμ), which starts a little after a photosynthetic increase, giving the initial cusp. This persists slightly after return to longer wavelengths (540 or 688 mμ), giving the depression, with quick recovery.

There is indication of the same effect on light-dark alternations at the same wavelengths. There are often cusps at 490 and 640 mμ, followed by enhanced respiration on darkening, while a smoother time course is found at 540 and 688 mμ, without notable respiration increase on darkening. This is in agreement with the manometric findings of Emerson and Lewis on *Chlorella*.

L. R. BLINKS
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Some New Theorems concerning Regular Polyhedra and Polytopes

Let any of the five regular polyhedra be projected orthogonally on an arbitrary plane P; the faces project into a network of triangles, parallelograms, or pentagons according to the case. Theorem I: *The mean square of the areas of the projected faces is independent of the choice of the plane* P, *being invariantly equal to* one-third *the* $(area)^2$ *of a face of the polyhedron.* Theorem II: *If the given regular polyhedron is an icosahedron or its dual, a dodecahedron, then also the mean* fourth power *of the areas of the projected faces is independent of the plane* P, *being equal* to one-fifth *the* $(area)^4$ *of a face of the polyhedron.*

A generalization to regular polytopes in n-dimensional Euclidean space is as follows. Let the r-dimensional faces of such a polytope be projected orthogonally on a k-flat contained in the n-space ($r \leqq k \leqq n$). Then the mean square of the r-volume (area, if $r=2$; length, if $r=1$) of these projected faces is equal to $f(n, r, k)\,(F_r)^2$, where F_r denotes the r-volume of an r-face, and

$$f(n, r, k) = k!(n-r)!/n!(k-r)!$$

A special theorem, pertaining only to the 600-cell (tetrahedra) and its dual, the 120-cell (dodecahedra), both contained in four-space, is as follows: Let the 1200 two-dimensional faces (720 two-dimensional faces) of the 600-cell (120-cell) be projected orthogonally on an arbitrary plane (that is, two-flat) in the containing four-space. Then the mean fourth power of the area of these triangular (pentagonal) projections is equal to 1/15 of the $(area)^4$ of a two-face of the given polytope regardless of the choice of the plane of projection.

JESSE DOUGLAS
Yeshiva University

On the Nature of Colicine K

The colicines are antibacterial agents of unknown nature which are elaborated by many strains of colon bacilli. From irradiated cultures of the colicinogenic microorganism *Escherichia coli* K235, it is possible to obtain a mutant which does not synthesize colicine K. The O antigen of this bacillus has been obtained from the culture media in an electrophoretically homogenous state.

A comparison of the immunological properties of the colicinogenic bacillus with those of the noncolicinogenic variant has revealed that their O antigens are identical save in one respect. That of the parent has potent bactericidal properties, whereas the antigen of the variant does not. The colicinogenic bacillus elicits antibodies in experimental animals which agglutinate the homologous microorganism and precipitate its purified O antigen (termed "purified colicine K") and which neutralize the antibacterial property of the latter. The antibodies evoked by the noncolicinogenic bacillus also agglutinate the homologous and heterologous organisms and precipitate purified colicine K, but without neutralizing it. Since the O antibodies elicited by the noncolicinogenic bacillus precipitate purified colicine K in its entirety, it must be concluded that the colicine is an integral part of the O antigen of the colicinogenic bacillus.

Although the gross properties of the O antigen derived from the noncolicinogenic bacillus resemble those of the antigen obtained from the parent microorganism, a comparison of their chemical make-up has not yet been made. Such a study should reveal differences which might in turn be related to the remarkable differences in the biological properties of these two agents.

WALTHER F. GOEBEL
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TSUNCHISA AMANO
Osaka University, Japan

Measurement of Magnetic Moments of Nuclear Excited States

Studies are at present under way in several laboratories with a view to measuring the magnetic moments of nuclear excited states. The methods of measurement generally used are subject to perturbations arising from the chemical environment of the nuclei studied.

We are engaged in a program of adapting recently refined detecting and timing techniques to study these perturbations and to obtain some results which may be considered free from these effects for states with lifetimes of the order of 10^{-9} second. The precession, in a magnetic field, of the radiation pattern observed by the angular correlation of successive radiations is determined as a function of time after formation of the excited state. Initial results with excited states of Cs^{131} and Ta^{181} appear promising and will be described. The magnetic moment of the 80-kev excited state of Cs^{131} is given by our measurements as 3.1 ± 0.2 nuclear magnetons.

This work was supported in part through AEC contract AT (30-1)-2098 by funds provided by the U.S. Atomic Energy Commission, the Office of Naval Research, and the Air Force Office of Scientific Research.

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Massachusetts Institute of Technology

Electron Microscopy of Retinal Rods in Relation to Localization of Rhodopsin

Rapid freezing preserves the visual pigments which form an integral part of all photoreceptors and should make it possible to apply the full resolving power of the electron microscope to a study of the molecular substrate of visual excitation. Thin sections of light-adapted and dark-adapted retinal rods of the frog, guinea pig, and rabbit were examined by electron microscopy; improved low-temperature fixation techniques and standard preparation procedures were used.

The techniques involve essentially rapid freezing of the fresh or glycerinated retinas with liquid helium II at $-227°C$, followed by substitution of the ice matrix at -130 to $-80°C$ with alcohols, or with solutions of heavy metal salts in alcohols, and embedding in methacrylate at temperatures of $-30°$ to $-60°C$ by photopolymerization with ultraviolet light. Under these conditions excellent morpho-

logical and histochemical preservation of the retina is obtained without noticeable displacement of the rhodopsin or of its derivatives. The transversally arranged layered structure of the external rod segments appears very compact, and in light-adapted retinas the constituent unit disks display an intermediate dense line 15 to 20 A thick, which had not been detected previously between the double layers. In dark-adapted retinal rods an electron dense component is found, associated with the double layers, which stains selectively with heavy metal salts, particularly platinum chloride. This material disintegrates under the electron beam while being observed in the microscope when the specimen holder is cooled to $-120°$C. Correlation of these findings with the available evidence on the localization of the visual pigment, rhodopsin, will be discussed.

This work was supported by the Atomic Energy Commission, contract No. AT(30-1)-2278, and by a grant (C-3174) from the National Institutes of Health.

HUMBERTO FERNÁNDEZ-MORAN
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Massachusetts Institute of Technology

Geochemical Method for Dating Obsidian Artifacts

A new dating technique, which depends upon the diffusion of water from the atmosphere into freshly worked obsidian artifacts, is evaluated and considered useful in the range 100 years well into the Pleistocene. Age is related to the thickness of the hydrated layer, as measured with the petrographic microscope. The diffusion front is sharp, and layers as thin as 0.5 to $\sim$ 30μ have been measured. The thickness of the hydrated layer seems to follow the diffusion law $x = k\sqrt{t}$, where x = thickness of the hydrated layer, t = time, and k is a constant which is dependent on the temperature of hydration and the composition of the glass but seems relatively independent of humidity of the environment.

Obsidian artifacts from localities of supposed known age as determined by C^{14} dating, archeological estimates, and historical dating in North, Central, and South America and in Asia Minor have been examined. Rate-of-hydration curves have been tentatively constructed for different temperature environments. Owing to uncertainties in the true ages of many of the artifacts, the following rates, k^2, are still tentative: northern Alaska, 0.37 ± 0.17 μ^2 per 1000 years; southern Alaska, 0.9 ± 0.3 μ^2 per 1000 years; the United States and the Central Mexican Plateau, 4.5 ± 0.7 μ^2 per 1000 years; Iraq, 7 ± 2 μ^2 per 1000 years; and coastal tropical America, 8.8 ± 2 μ^2 per 1000 years.

Several Egyptian artifacts made of a trachytic glass, very different in composition from the other artifacts examined, hydrated at a rate of 13 ± 3 μ^2 per 1000 years.

Although the majority of the artifacts examined fit the above hydration rates, there are some exceptions.

IRVING FRIEDMAN, ROBERT L. SMITH
U.S. Geological Survey

Experimental Tests of Symmetry Principles

The recently discovered breakdown of parity and charge conjugation invariance in weak interactions has again demonstrated the danger of assuming a priori that physical systems possess particular invariance properties. An examination of the experimental evidence for some symmetries which are usually assumed has been made. These include the so-called "absolute" conservation laws, such as conservation of charge and of baryons; the invariance under rotations, which is related to the conservation of angular momentum, and the still unknown principle which appears to imply equality of the charges of certain elementary particles.

The most sensitive test of the absolute conservation laws seems to come from lower limits on the lifetimes of states which could decay except for these conservation laws. An experimental lower limit of 10^{17} years for the lifetime of atomic electrons (E. der Mateosian and M. Goldhaber, unpublished) places an upper limit on the strength of possible charge nonconserving interactions for electrons which is less by several orders of magnitude than the strength of the "weak interactions." The experimental lower limit of 10^{23} years for the lifetime of the proton puts a still lower limit on the strength of interactions which do not conserve baryons.

It is shown that the conservation of charge and existing reactions among elementary particles do not by themselves determine the relative charges of the electron, proton, and neutron. From experiment it is known that

$$|Q_p + Q_e| < 10^{-13}|Q_e|$$

and

$$|Q_n| < 10^{-13}|Q_e|$$

This may indicate the existence of some further principle which determines the charges of all elementary particles.

This work was done under the auspices of the U.S. Atomic Energy Commission.

M. GOLDHABER, G. FEINBERG
Brookhaven National Laboratory

Prevention of Mammary Cancer by Endocrinologic Methods

The oral administration of optimal amounts of certain aromatic polycyclic hydrocarbons to young, adult, female Sprague-Dawley rats resulted in the rapid, selective, and invariable production of mammary cancer. The earliest cancer was detected at 22 days, and every rat had multiple mammary cancers within 60 days. This technique for the rapid induction of mammary cancer facilitates the study of the conditions involved in the formation of breast cancer; hormones are critically involved.

Progesterone and related gestational steroids accelerated the onset and growth of mammary cancer incited by the carcinogenic phenanthrene derivatives. Large amounts of estradiol-17β block the carcinogenesis. Small amounts of this steroid have a permissive effect in carcinogenesis but, remarkably, block the vast stimulatory effects of progesterone. There are two highly effective methods of preventing mammary cancer. Hypophysectomized rats developed no cancer in 8 months. Likewise, a very effective method of preventing mammary cancer in rats treated with carcinogens is the simultaneous administration of large amounts of equine gonadotrophin, which evoke intense ovarian activity.

The development of mammary cancer with oral carcinogens is conditioned by limiting amounts of hormones, and it would appear that there are common binding sites for carcinogens and steroids in the mammary epithelium.

CHARLES HUGGINS
GIULIANO BRIZIARELLI
Ben May Laboratory for Cancer Research, University of Chicago

On a Symmetry in Weak Interactions

It appears that all the decays of the elementary particles can be explained by the universal V-A (V, vector; A, axial vector) interaction. The V-A four-fermion interaction can be derived from chirality invariance [E. C. G. Sudarshan and R. E. Marshak, *Proc. Padua-Venice Conf. Sept. 1957; Phys. Rev.* **109**, 1860 (1958)], two-spinor theory [R. P. Feynman and M. Gell-Mann, *Phys. Rev.* **109**, 193 (1958)], or mass reversal invariance [J. J. Sakurai, *Nuovo Cimento*, **7**, 649 (1958)]. However, the decision as to the fermions which enter into the fundamental interaction is made on purely phenomenological grounds (that is, to allow the observed decays and to forbid the unobserved decays). Arguments are given for regarding the baryon triplet (λ hyperon, neutron, proton) as the analog of the lepton triplet (muon, electron, neutrino) insofar as weak interactions are concerned. It is shown that the symmetry principle

$$\lambda \rightleftarrows \mu,\ n \rightleftarrows e,\ p \rightleftarrows \nu$$

leads to no contradiction with the present experimental data and makes some new predictions which can be tested experimentally. It is also possible to introduce the notion of "weak" strangeness for the leptons (which reduces to "strong" strangeness for the baryons) and to derive a unified relation between the charge, the third component of the isotopic spin, the strangeness, and the baryon (or lepton) charge. The role of an intermediate-charged, heavy-vector boson will be discussed within this framework.

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Effect of Spreading Technique and Purity of Sample on Retardation of Evaporation by Monolayers

It was suggested by Archer and La Mer [*J. Phys. Chem.* **59**, 200 (1955)] that the retardation of evaporation of water achieved by spreading monolayers on the surface is extremely sensitive to contamination, from the air, from impurities in

the aqueous subphase, and from retained molecules of the spreading solvent. To avoid such contamination they devised a special spreading technique (using concentrated spreading solutions and high initial surface pressures); this, however, gave crystals of the compound forming the monolayer on the surface. Their method was therefore limited to one-component monolayers. Since our objective was to study mixed monolayers, we have reinvestigated the technique of spreading the monolayer by the conventional method of using dilute spreading solutions and zero initial surface pressures. By adopting stringent precautions against contamination we have now obtained satisfactory results with the conventional spreading technique and have shown that under the conditions of our investigations the evaporation resistance of a monolayer is independent of the spreading technique used. This shows, incidentally, that results obtained with the Archer-La Mer technique are reliable for one-component monolayers.

We have investigated a number of stearic acid samples from different sources. It is clear that impurities in some of these samples produce marked diminution of the resistance to evaporation by the monolayer, particularly at low surface pressures. It appears that the evaporation resistance of a monolayer is much more sensitive to impurities in the sample than are most of the physical and chemical tests that are normally used as criteria of purity.

VICTOR K. LA MER
GEOFFREY T. BARNES
Columbia University

Sugar Nucleotides in the Interconversion of Carbohydrates in Plants

Experiments with plant extracts from mung beans and other plants have demonstrated the presence of enzymes (pyrophosphorylases) capable of catalyzing the reversible formation of a number of sugar nucleotides according to the general reaction:

Uridine triphosphate (UTP) + sugar 1-phosphate
Uridine diphosphate (UDP) sugar + pyrophosphate

UDP-D-glucose, UDP-D-galactose, UDP-D-xylose, UDP-L-arabinose, UDP-D-glucuronic acid, UDP-D-galacturonic acid, and UDP-acteylglucosamine were thus enzymatically synthesized by this reaction. With the exception of UPD-D-galacturonic acid, the nucleotides were shown to be present in mung beans.

The following other enzymatic systems have been shown to exist in plants: (i) kinases capable of phosphorylating D-glucuronic acid, D-galactose, and L-arabinose, forming the corresponding sugar *l*-phosphates; (ii) a UDP-D-glucose dehydrogenase which oxidizes UDP-D-glucose to UDP-D-glucuronic acid; (iii) a decarboxylase capable of decarboxylating UDP-D-glucuronic acid to UDP-pentose; (iv) 4-epimerases that catalyze the interconversion of UDP-D-xylose and UDP-L-arabinose, UDP-D-glucose and UDP-D-galactose, and UDP-D-glucuronic acid and UDP-D-galacturonic acid; (v) transglycosylases that catalyze the formation of sucrose, callose (β-1,3-linked glucan), and a number of naturally occurring glycosides from UDP-D-glucose; and (vi) a transxylosylase which transfers xylosyl residues from UDP-D-xylose to xylo-oligosaccharides.

Thus it has been found that the sugar nucleotides are key intermediates in the pathways that lead to the formation of oligosaccharides, glycosides, and plant cell-wall constituents.

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Kitt Peak National Observatory—Past and Present

In January 1954, at the request of the Advisory Panel for Astronomy to the National Science Foundation, a committee was formed to explore the idea of establishing an interuniversity astronomical observatory as a way of stimulating the study of astronomy in the United States.

After several years' study, the committee offered the following recommendations to the National Science Foundation. (i) Funds should be provided for a thorough survey of possible sites for a proposed national astronomical observatory. (ii) Approximately $3.6 million should be provided for the construction of 80-in. and 36-in. stellar telescopes, and associated facilities, which would form the nucleus of the observatory. (iii) Approximately $5 million should be provided in fiscal year 1959 for an addition to the observatory of the world's largest solar telescope.

These recommendations were followed, and a nonprofit organization, the Association of Universities for Research in Astronomy, was incorporated by seven member institutions in October 1957, to administer and operate the national observatory as contractor to the National Science Foundation.

A survey of more than 120 possible sites in the United States and its possessions resulted in the final selection of Kitt Peak, 42 miles southwest of Tucson, Arizona.

A completed 36-in. telescope is expected to be operating from Kitt Peak by the end of the summer of 1959. Drawings for an 84-in. telescope have been finished. Designs for the 60-in. solar telescope are well along. Construction should start before 1961. Offices, research space, and the principal shops—optical, instrument, and electronic—are being built in Tucson.

ROBERT R. MCMATH
McMath-Hulbert Observatory, University of Michigan

Reproductive Cycles in an Equatorial Sparrow

Investigation of a free-living population of the Andean sparrow, *Zonotrichia capensis*, was directed for a period of 1 year, in Colombia, South America, toward determining the number and duration of reproductive cycles at equatorial latitudes where seasonal photoperiodism is not an influencing factor. The species may nest in all months of the year, but it was found that each individual adult male has a testis cycle of approximately 6 months' duration, in which full reproductive capacity is usually sustained for 4 months and the pituitary-gonad mechanism is involved in full rest and reconstruction for 2 months. Two complete cycles are thus carried out in a year and are a reflection of an innate rhythmic tendency uncoerced by photoperiodism and only slightly influenced by seasonal rainfall.

Information was obtained by color-banding individuals, observing them daily, and recapturing them periodically to permit laparotomy and inspection of the internally situated gonads. This surgical technique and one involving examination of the skull for age determination did not disrupt normal nesting and breeding behavior. Males are actually engaged in mating and nesting only for limited periods in the course of the time that they are physiologically capable of reproduction. Some of the young birds attain breeding condition as early as 5 months of age, but in some it is delayed to as late as 11 months.

ALDEN H. MILLER
University of California, Berkeley

Evidence of the Genetic Basis for X-ray–Induced Life-Shortening

While there is evidence that acute radiation-induced mortality in higher forms is due to the production of chromosomal damage, a genetic basis for radiation-induced shortening of the life span has not yet been demonstrated. *Drosophila melanogaster* seems well suited as a test subject for an attack on this problem. Not only can appropriate stocks be readily obtained but exposure of preimaginal stages that would soon be followed, normally, by a period of intensive cell proliferation, growth, and differentiation results in a relatively early onset of damage, whereas in vertebrates damage would be long delayed. Thus, death resulting shortly before or after eclosion, 4 to 5 days following irradiation of larvae, probably represents a shortening of life comparable in principle to that observed in mammals.

The finding that more male than female larvae are killed by x-rays (Oster and Cicak, 1958) suggested that this mortality is genetically based, since breakage followed by loss of its one X chromosome would kill a male cell, whereas a female cell would be protected by its other X chromosome. Subsequent experiments showed that, as expected, survival to adulthood following a given dose was much higher for males with a normally structured "rod" X chromosome (174/550) than for males with a ring X chromosome (103/650); it was hardly higher for females with two normal X's (215/350) than for females with one rod and one ring X (210/350), but higher than for females with attached X's (63/150). Although chromosome breakage could kill

somatic cells by either bridge-formation or hypoploidy, these results clearly implicate chromosome loss by breakage as the chief cause of this radiation induced "ageing."

This work was supported by a grant to H. J. Muller and associates from the U.S. Atomic Energy Commission [contract No. AT(11-1)-195].

IRWIN I. OSTER
Institute for Cancer Research

Movement of Heat, Chloride, and Water in Salt-Marsh Peat

The annual cycle of temperature at depth in a salt marsh has been measured to determine whether water moves through the peat fast enough to disturb the temperature relations to be expected if the water is stagnant. The measurements indicate, as a first approximation, that the temperature cycle is undisturbed, but suggest that there is a slow movement of water downward through the peat layer.

At the point of observation the interstitial water in the lower layers of peat contains almost no chloride; this indicates that the ground water in the substratum, at 15 ft depth, is fresh and that the water within the peat mass is a mixture of ground water and salt water derived from the surface. The distribution of chloride with depth may be accounted for on the assumption that there is an upward advection of ground water accompanied by a mixing process carrying salt water downward.

The two lines of inquiry thus give conflicting results concerning the movement of water. Observations by more direct methods, such as the use of tracers, are needed to resolve this difficulty, and particularly to examine the horizontal circulation. In any case the movement of water is so slow that the temperature cycle is not greatly disturbed.

It is suggested that the peat mass preserves a short-term record of recent temperatures which may be of value in climatological studies, and on the other hand that the movement of water must be considered in examining the chemistry of ancient peat deposits.

ALFRED C. REDFIELD
Woods Hole, Massachusetts

Low-Velocity Zone in the Upper Mantle of the Earth

Amplitudes of seismic body waves from explosions and the dispersion of long surface waves from earthquakes require the assumption of the existence of Gutenberg's low-velocity zone in the upper mantle.

Data are presented to indicate that this zone is present under continents and oceans at a depth of about 150 km. The low-velocity zone could account for the long-period nature of S waves and may be the source of the primary basaltic magma.

FRANK PRESS
California Institute of Technology

Role for Coenzyme A in Oxidative Phosphorylation

The uptake of inorganic phosphate by respiring submitochondrial particles was found to be enhanced by a factor liberated in soluble form when mitochondria are ultrasonically oscillated for 15 seconds in distilled water. The factor can be replaced by coenzyme A but not by a wide variety of other thiol compounds. Coenzyme A enhances the conversion of inorganic phosphate to adenosine phosphates but has no influence on the respiration which yields energy for this synthesis. It also enhances the exchange of inorganic phosphate with adenosinetriphosphate.

With intact mitochondria, depletion of coenzymes by treatment with phosphate buffer for 10 minutes at 37°C depresses—and coenzyme A partially restores—adenosinetriphosphatase activity. A role for coenzyme A in oxidative phosphorylation will be discussed.

HENRY A. LARDY
University of Wisconsin

Genetic Studies on Enzymes in Maize Endosperm

The technique of starch gel electrophoresis is being employed in a study of the enzymes involved in starch synthesis and degradation. The experiments are designed to compare enzymatic differences produced by a series of mutants which affect starch synthesis in maize endosperm. Since starch is the substrate upon which these enzymes act, their rate of migration in the gel is dependent not only on charge and size but also on their affinity for the substrate. By staining the gel with iodine it is possible to detect the enzymes that are active on the starch. They appear as red bands on the blue background. These bands show the slowest migration rate in the gel, as determined by protein staining, and are thus separated from the other soluble proteins in the extract. One of these bands has been tentatively identified as beta-amylase. It increases the opacity of the gel, and its migration can be followed during the electrophoretic separation.

Preliminary studies with the sugary mutant have revealed some differences in banding pattern which could be due to alterations in either charge or substrate affinity. All of the known mutants which affect starch synthesis in the endosperm are being tested. Those enzymes that show different banding patterns in the mutants are to be isolated and analyzed in an attempt to pinpoint the alterations caused by the mutant gene.

DREW SCHWARTZ
Oak Ridge National Laboratory

Large Molecules in Carbon Vapor

The molecular orbital theory is used in appropriate semiempirical forms to predict the properties of carbon vapor. The results indicate that linear polyatomic molecules $:C{=}C{=}C-\!-\!-\!-C{=}C:$ are the important species. Experimental results from the literature for C_3 are combined with the calculated conjugation or resonance energies and with the heats of formation of allene and ethylene to predict heats of formation for all larger carbon molecules. It is found that the odd species have closed shell structures and lower energies than the even species but that the even species should show greater electron affinity. Both of these results are consistent with the mass spectrometric results of Honig and of Chupka and Inghram. Molecular spectroscopic data on C_3O_2 are used to estimate the free energy function increments for the species above C_3.

The calculated partial vapor pressures predict C_5 to be the most abundant species in the saturated vapor even at 2000°K, with C_7 becoming comparably abundant in the 2500 to 3000°K range. At higher temperatures even larger molecules should become important. The results are shown to be generally consistent with all reliable vaporization data, provided the evaporation coefficients decrease rapidly for increasing molecular size and vary for different crystal surfaces of graphite.

The calculated electronic energy levels for C_2 and C_3 agree satisfactorily with the observed spectra, and trends are predicted for both even and odd larger species. It is proposed that liquid carbon consists of essentially infinite linear chains of this type. Considerations of both entropy and energy lead to the prediction of heats of fusion of about 10 kcal/g atom at 4000°K; the agreement between the two values indicates at least the absence of any serious inconsistency.

KENNETH S. PITZER
ENRICO CLEMENTI
University of California, Berkeley

Relation between Reproductive Capacity of Polio Viruses at Different Temperatures in Tissue Culture and Neurovirulence

It was recently reported [A. Lwoff and M. Lwoff, *Compt. rend.* **248**, 154 (1959)] that temperatures of 39° to 41°C affected only slightly the reproduction in KB cells of the highly virulent Mahoney strain of type 1 polio virus but greatly inhibited attenuated strains, the extent of inhibition being related to the degree of attenuation. While a variety of other in vitro characters have previously been correlated with neurovirulence for monkeys, studies on reverse mutants failed to establish any one of them as an important determinant of the complex property of neurovirulence. The present studies, however, showed that the genetic factors which influence the reproductive capacity of polio virus at higher temperatures are very closely correlated with neurovirulence. Thus, mutants of the moderately attenuated "Brun-End-Chimp" strain and of the highly attenuated "L Sc, 2 ab" strain, which were selected by stepwise cultivation in KB cells at increasingly higher temperatures until they reproduced well at 41°C, proved to be fully virulent on intracere-

bral inoculation of as little as 1.7×10^1 PFU in monkeys, while repeated passages of these strains in KB cells at 37°C yielded virus that was not paralytogenic in doses of 10^8 PFU. On the other hand, while minimal doses of the original "Brun-End-Chimp" virus were paralytogenic when placed directly in the gray matter of the lumbar spinal cord of monkeys, a mutant selected for its capacity to reproduce at 25°C was not paralytogenic in doses of 10^6 PFU; this confirms an observation on other strains of polio virus originally reported by Dubes and Wenner [*Virology* 4, 275 (1957)].

Titration of polio viruses in monkey kidney monolayer cultures incubated at 36° and 40°C has proved helpful in differentiating highly virulent from attenuated strains, but not in distinguishing quantitative differences in neurovirulence as determined by tests in monkeys. Highly attenuated type 1 and type 2 strains exhibited little or no change in their limited capacity to reproduce at 40°C in tissue culture after multiplication for many weeks in the intestinal tract of children, even when a febrile illness (38°–40°C) intervened. Partial modification in the reproductive capacity at 40°C of excreted type 3 virus was not correlated with neurovirulence for monkeys.

ALBERT B. SABIN
University of Cincinnati College of Medicine
ANDRE LWOFF
Institut Pasteur

Extreme Sensitivity of an Immature Stage of the Mouse Ovary to Sterilization by Irradiation

Comparisons of the fertility of female mice irradiated at various stages from the embryo to the adult revealed that, during the first 2 weeks after birth, the ovary shows a remarkable change, from less sensitivity than is found in the adult to much greater sensitivity.

Females receiving 300 r of x-irradiation (80 to 90 r/min) on the day of birth, when most oocytes are apparently in pachytene stage, commonly produced nine or ten litters, whereas adult females given the same acute dose never produced more than two litters (mean: 1.4).

In contrast to this marked resistance of the ovary of the newborn, the ovary during the second week after birth shows an extreme sensitivity, even to low-intensity irradiation. A total dose of 85 r of continuous Cs^{137} gamma irradiation given during this week (dose rate only 0.0084 r/min) caused sterility after production of either a single litter or a second litter of reduced size. Sensitivity to low-intensity irradiation rapidly diminishes after this stage. Adult females given approximately the same total dose at the same dose rate produced an average of 13.3 litters and 86 progeny per female (numbers which are not significantly different from those for controls).

The much greater sensitivity during the second week after birth coincides with the time when oocytes have recently reached dictyate stage. It is quite possible that the comparable stage of development of the human ovary, which is apparently attained before birth, has a similar extreme sensitivity to radiation.

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LIANE BRAUCH RUSSELL,
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Oak Ridge National Laboratory

Light, Growth, and Reproduction of Poria ambigua

Poria ambigua does not form hymenium and basidiospores on a basal agar medium containing dextrose, mineral salts, B vitamins, purine and pyrimidine bases, and casein hydrolyzate unless exposed to light. The blue end of the visible spectrum is effective, the red end is not. Short exposures to faint light are adequate. The effect of light extends into mycelium, which grows in the dark after illumination. This suggests the production of a substance in the light which moves into mycelium formed later in the dark and induces reproduction. The addition of natural substances such as tomato juice, yeast extract, or malt extract to the basal medium increases growth and interferes with reproduction. Local inhibition of growth on such media by actidione permits hymenium to form. Different isolations of the fungus vary in their reproductive potency. Light also affects the rate of growth of the fungus, decreasing it on some media and increasing it on others.

It is proposed that three unidentified growth substances may be concerned: x is formed in the light and is required for the series of physiological and morphological changes which result in reproduction. The ability of the fungus to synthesize y limits growth on the basal medium and is found in natural substances. Substance z limits growth in the dark in the presence of luxus amounts of y. The synthesis of z is favored by light, with the result that growth in the presence of adequate amounts of y is greater in the light than in the dark.

WILLIAM J. ROBBINS
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ANNETTE HERVEY
New York Botanical Garden

Biogeochemical Concentration of Deuterium in the Marine Environment

During studies of the calcium carbonate deposits of the Bahama Banks, conducted by the U.S. Geological Survey in 1955 and 1956, a hydrogen-gas–producing marine bacterium, occurring in high concentration within the superficial sedimentary layer, was isolated. Mass spectrometric analyses of the gas generated by this microorganism revealed an unexpectedly high percentage of light hydrogen (protium) and an apparent absence of the normal isotope, deuterium, in the gas mixture.

Subsequent analyses of the sea water dextrose substrate used to culture this marine bacterium showed the normal distribution of the protium-deuterium isotopes. It was apparent that the deuterium in the medium was being selectively fractionated by the cellular biochemical processes.

Since publication of these initial findings [*Science* **127**, 1394 (1958)], interest aroused as a result of this chance discovery has prompted a renewal of that phase of the Bahama Banks study connected with the equilibrium

$$H_2O + HD \rightleftharpoons H_2 + HDO$$

Particular attention has been focused on the precise biochemical mechanism which may be responsible for the initial separation of protium and deuterium. This is not only a matter of academic interest; a more thorough understanding of the biochemical processes involved in separation and concentration of deuterium may have economic and public health implications. Such understanding could facilitate the production of heavy water and lead to reduction in the cost of producing it, and it could give a clearer insight into the biochemical processes associated with aging and abnormal tissue development.

Of academic import is the possible significance of the role of marine bacteria in the concentration of heavy water in the seas during past geologic time. Today, sea water contains from 10 to 25 percent more D_2O than fresh water, the atmosphere, ice, and igneous rock.

Marine bacteria are undoubtedly important agents in the separation and accumulation of many other rare elements besides deuterium in the marine environment.

F. D. SISLER
U.S. Geological Survey

Elimination of Deoxyribonucleic Acid from Soma Cells

Current wide-spread interest in the role of deoxyribonucleic acid (DNA) in protein synthesis brings into the foreground an old enigma of cytology—the elimination of parts of, or of whole, chromosomes from the soma cells of an embryo so that the somatic chromosome complex may be quite different from that of the germ cells.

Evidence will be reviewed indicating that the excess DNA of germ cells plays an essential role in the building up, in the cytoplasm of the oocyte, of great reserves of proteins and nucleic acids required for the development of embryos to the stage when they can obtain food from the environment. The elimination of the excess DNA from soma cells is highly advantageous to the organism because it frees soma cells, or nuclei, from the necessity of synthesizing anew, or reassembling nucleotides not required for somatic cell development, thus conserving the supply of nucleic acid precursors previously stored in the cytoplasm of the oocyte. In this way the more rapid development of the embryo is possible.

THEOPHILUS S. PAINTER
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Ionic Centrifuge and Fusion Nuclear Power

The ionic centrifuge [J. Slepian, *Phys. Rev.* **112**, 1441 (1958); *Nuclear Sci. and Eng.* **3**, 108 (1958)] proved unsatisfactorily for the separation of isotopes because of the high energy of random motion or high temperature received by the ions and electrons traversing the induced currents in the gas. This action is reversible, however, and the temperature may be again lowered by making the ions and electrons traverse currents opposite in direction to those to which they had been originally subjected.

The procedure is as follows: Connect the cylinder of the centrifuge directly to the short arc. Energize the end plates positively, but not too highly positively. They then draw only a space-charge-limited electron current. The main central discharge going from arc to cylinder bears only a radial electric field, which rises to a high positive potential and falls again to zero potential on coming to the cylinder. Electrons from the central discharge crowd up and down into its boundaries, their freed electric field lying up and down parallel to the magnetic field; then, beyond the voltage maximum, they draw back into the central discharge again. This motion out and in of the electrons from the positive ions constitutes radial and axial current densities in the gas. In addition, there will be circumferential current densities which change sign on passing the voltage maximum. The temperature of the ions and electrons rises on traversing the circumferential currents prior to the voltage maximum and then falls again to zero on traversing the reversed circumferential currents from voltage maximum to the cylinder.

Thus, we have here high-temperature ions and electrons out in space, with only low-temperature ions caught by the electrodes. The application of this to the generation of fusion nuclear electric power is obvious.

JOSEPH SLEPIAN
Pittsburgh, Pennsylvania

Maximum Growth Rates in Synchronized Cultures of Green Algae

The minimum generation time, or doubling time, for the low-temperature strains of *Chloreila* has long been known to be near 8 hours. The minimum generation time for the recently introduced high-temperature strains of *Chlorella* has been reported to be 2.5 hours in steady-state suspensions. By culturing high-temperature algae in synchronized suspensions, the doubling time was reduced to 1.8 hours and, with the further refining of the technique, to 1.5 hours. Calculated on a 24-hour basis, the increase in dry weight for the low-temperature algae in steady-state culture is eightfold; for the high-temperature strains the increase is 1000-fold. In synchronized cultures of the high-temperature strains, the increase is 64-fold in 9 hours. If this multiplication rate could be sustained for 24 hours, the dry weight of the algal cells would increase by a factor of 65,000.

The difference in the rates of reproduction between synchronized and steady-state cultures may be due to the suspected detrimental effects of strong light on cell division and, consequently, on the over-all process of growth. The adverse effect of light is eliminated in synchronized culture, since no visible cell division takes place during 9 hours. Another possible explanation is the absence of older cells from the synchronized cultures. Algal cells approaching the end of the life cycle have a reduced metabolic activity and, therefore, can be expected to have a lower growth rate.

CONSTANTINE SOROKIN
ROBERT W. KRAUSS
University of Maryland

On the Possibility of Avoiding Infinities in Quantum Field Theory If Space-Time Is Curved

We consider the second quantization for bosons of the theory for a single particle. With (isotopic) spin this will cover such fermion-boson theories as can be expressed in terms of bosons only by the apparatus of the neutrino theory of light. The corresponding nonquantum theory in curved space-time can be reduced to canonical form and then can be quantized in the usual way. We here consider the simplest case of a particle without spin in curved space-time with but one space-dimension, invariant for observers with various velocities at each point-event.

If we express the first quantized theory in terms of the rapidity u, the momentum and energy operators for a free particle are $X_0 = mc \sinh(u/c)$ and $H_0 = mc^2 \cosh(u/c)$. A relativistically invariant interaction is introduced by taking further momentum and energy

$$X_1 = (X_0, J), \; H_1 = (H_0, J)$$

where J is a matrix of the form

$$(u_1|J|u_2) = J(u_2 - u_1).$$

If J falls off sufficiently rapidly as $(u_2 - u_1)$ increases, it provides an invariant "cut-off," and powers of the operators are finite, but $(X, H \neq 0$, and space-time is curved. If J is a constant, which corresponds to the usual type of field interaction, powers of the operators are not finite. Further, the limit of space-time curvature as this last form is approached is not zero, but rather a δ-function of effective distance from a particle.

L. H. THOMAS
Watson Scientific Computing Laboratory

Restoration of Antibody-Forming Capacity in X-rayed Rabbits

As compared to controls, rabbits that received 400 r of total-body x-irradiation 24 hours before receiving injections of 1.6×10^9 red cells of sheep showed on the average a 2.7-fold lengthening of the induction period, a 36-percent lower rate of rise in antibodies, and an 88-percent lower geometric peak titer.

Earlier we found [*J. Infectious Diseases* **98**, 75 (1956)] that antigen mixed with minces or extracts of rabbit or mouse spleen (but not of rabbit kidney or muscle) partially restored the rate of rise and peak titer. Preparations of yeast and HeLa cells were completely restorative. Recently ribonucleic acid and deoxyribonucleic acid enzymatically degraded by their specific nucleases were found to be partially restorative, but the nucleic acids and pure nucleosides and nucleotides were inactive. Among chemically defined substances, kinetin partially restored and colchicine completely restored the rate of rise and peak titer. Little if any antibody is synthesized during the induction period, and no restorative substance affected the x-ray lengthening of this period. Restoration is probably related to the early radiosensitive period of the immune process which determines the amount of antibody formed and eventually involves some aspect of the nucleic acid control of protein synthesis.

WILLIAM H. TALIAFERRO
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BERNARD N. JAROSLOW
Argonne National Laboratory

Cellular Differentiation through Asymmetrical Mitosis and Mitotic Induction in the Developing Epidermis of the Grass Leaf

In leaves of grasses, exemplified by barley, orchard grass, maize, and sorghum, stomata occur in vertical rows on either side of each vascular bundle. Each stomatal complex includes two guard cells flanked by two subsidiary cells; these alternate regularly with undifferentiated epidermal cells. Differentiation proceeds in the intercalary meristem at the base of each leaf and can be studied from strips of leaves fixed in Carnoy's fixing fluid and stained in acetocarmine or Fuelgen stain. Differentiation of the stomatal rows is evident through more frequent mitoses, which give rise to cells smaller than those in adjacent rows. The final series of mitoses is asymmetrical. Immediately after telophase, the distal nucleus becomes small and strongly staining and the proximal nucleus becomes larger and more weakly staining. Shortly thereafter, cells in adjacent rows divide, their mitotic spindles being consistently oriented with one pole adjacent to the smaller cells in the stomatal row.

Evidence is presented indicating that the latter cells induce both this orientation and the mitoses themselves. At telophase, these give rise to a small cell with a heavily staining nucleus adjacent to the stomatal row and a large nucleus in the middle of the original cell. These small cells become the subsidiary cells of the stomatal complex. Immediately after their formation, the smaller cells in the stomatal row divide transversely and eventually become the guard cells. Differentiation can be altered by applying mercapto-

ethanol, isopropyl-phenyl carbamate, and other chemical agents.

The significance of this system as a tool for studies of morphogenesis and developmental genetics is discussed. This research was conducted with the aid of National Science Foundation grant No. G-3737.

G. LEDYARD STEBBINS
University of California, Davis

Further Electron Micrographic Observations on Indanthrene Dyes

In a previous communication we showed that under the electron microscope crystals of a number of indanthrene dyes exhibit molecular striations like those first observed with metallic phthalocyanins. We have been continuing these observations to provide the experimental basis for understanding them. Striae can be seen in crystals viewed close to and far from focus; accordingly, it was at first thought that they were insensitive to focus. This has proved not to be the case.

In the present communication it is shown how the complex pattern of striae furnished by the dye indanthrene scarlet R varies as a function of objective lens current of the viewing microscope. Similar though less complicated changes have been observed for copper phthalocyanin and for indanthrene olive TWP.

A number of other observations important for interpreting these phenomena, such as their dependence on crystal thickness, have been made. The basic spacings observed with scarlet R, like those of the phthalocyanins, can be identified with important x-ray diffraction lines. Fine structure in the interference pattern produced by this dye depends on focus; it is related to, but need not equal, the basic spacings.

R. W. G. WYCKOFF
L. W. LABAW
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Evidence by Isotope Tracers of Perpetual Replacement of Mature Nerve Fibers from Their Cell Bodies

According to earlier findings (Weiss, 1944; Weiss and Hiscoe, 1948), the axon of a nerve fiber grows forth perpetually from the nucleated cell body at about 1 mm per day, furnishing a steady supply stream to replenish peripheral macromolecular systems, including proteins, lost by metabolic degradation. Attempts to demonstrate this "axonal flow" by radioactive phosphorus (Shepherd, 1951; Samuels, Boyarski, Libet, and Brust, 1951; Ochs and Burger, 1958) have been suggestive but not conclusive. More positive preliminary tests with C^{14}-lysine (Waelsch, 1958) have led to the present crucial tests.

These were carried out in large Mexican axolotls whose lateral line nerves (length $>$ 200 mm) contain the same ($\pm$) 40 nerve fibers from center to periphery. Each animal received a single intraperitoneal injection of a mixture of C^{14}-labeled lysine, leucine, isoleucine, valine, and phenylalanine (the injections were given with the collaboration of Waelsch and Lajtha). After 168 and 214 days, respectively, the lateral line nerves were excised and radioautographed. Photodensitometric scanning of the autographs revealed a marked linear gradient of radioactivity from center to periphery, indicating that amino acid incorporation into nerve protein had been confined to the cell bodies, the labeled mass being conveyed peripherad at a rate which, to judge from the front end of the labeled column, is of the predicted order of 1 mm per day. The gradient is attributable to the continual feeding back of peripheral, C^{14}-labeled, split products to the central source of neuroplasm, the fronts of consecutive waves being correspondingly staggered.

The experiments seem to confirm the earlier findings that the neuron is in a state of continuous self-renewal from the local source of the nucleated cell space. If the results can be extrapolated to other cell types, protein synthesis in general would have to be localized in the nuclear territory.

PAUL WEISS
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Note on the Internal Structure of the Moon

The moon has a triaxial nonequilibrium shape, as determined from its motion and its proper libration. It has been assumed that this was acquired when the moon solidified, at a lesser distance from the earth than it is now. This requires great strength in the moon's interior, and it is difficult to reconcile this with probable interior temperatures. It is possible to explain this as being due to a variation in density with angular position within the moon. Surface variations in density will not affect the ellipticities to a first approximation in small quantities. In this case great strength must exist in the outer parts but not in the deep interior. Such variation in density may be due to variation in composition, indicating a slightly heterogeneous structure with angular position. A nonuniform structure is indicated, suggesting that the moon was never melted.

The recent observations of Kozyrev also indicate that the moon's temperature is increasing rather than decreasing. Tidal effects on the moon due to the varying earth-moon distance may give rise to reported lunar surface patterns.

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Directed Formation of the Actinomycins—Chemical Structure and Biological Activities

Actinomycin, discovered in 1940, was the first antibiotic isolated from a culture of an actinomycete; however, it was found to be too toxic for use in the treatment of infectious diseases. Later, it proved to be effective in very low concentrations against certain experimental neoplasms in animals. Various attempts have since been made to modify the chemical structure of the molecule, both by chemical means and by enzymatic degradation, in an effort to reduce its toxicity. The substances generally obtained as a result of such treatment proved to be less toxic but also less active biologically. Numerous actinomycin preparations have been isolated from different *Streptomyces* species; those examined proved to be chromopeptides, differing solely in their amino acid composition. They revealed slightly differing toxicities and somewhat different effects upon microorganisms and experimental neoplasms.

Streptomyces antibioticus synthesizes a mixture of five or six actinomycin components. The nature of the nitrogen source influences greatly the quantitative and qualitative composition of the actinomycin mixture synthesized. Sarcosine selectively affects the production of actinomycins II and III. High concentrations of exogenous L-proline reverse this effect. The addition of DL-pipecolic acid to the medium results in the synthesis of several new actinomycins. Actinomycins II and III proved to be somewhat less toxic than the previously examined actinomycins and still possessed activity against the ascitic form of the Gardner lymphosarcoma. Actinomycin II contains four residues of sarcosine but no proline, whereas actinomycin III contains three residues of sarcosine and one molecule of proline. The results obtained are compatible with the view that exogenous sarcosine and pipecolic acid compete with and replace the endogenously synthesized proline in the peptides of some of the actinomycins.

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