fittings of the pneumatic tube system of the reactor. Probably the zinc is carried into the reactor, irradiated, and, on removal, inhaled by the reactor workers.

Group B was composed primarily of pile operators and other personnel such as health physicists who work on or near the reactor. These people were selected on the basis of having higher than normal levels of activity in their urine. Over 66 percent of the individuals in this group had Zn^{65} body burdens in the range of 40 to 120 $\mu\mu$c/kg of body weight.

Group C was composed of personnel working in the reactor building but presumably having minimal occupational exposure and no detectable level of activity in the urine above background.

Group D was composed of individuals who represent part of a continuing survey of Brookhaven personnel and serves here as a control group against which the spectral data of the reactor workers can be compared. The Zn^{65} levels in groups C and D are below the limit of detection of the whole-body counting apparatus for a 30-minute count.

In addition to the Zn^{65} activity, Cs^{137} and K^{40} were measured in all subjects. The K^{40} content averaged 1.84 g/kg of body weight. This figure agrees well with K^{40} measurements in other similar studies (*11–13*).

The level of Cs^{137} has had a world-wide increase since 1955 and appears to have reached a maximum value in 1959 in the world population (*11–14*). In the present study, the average was 59 $\mu\mu$c/g of potassium in nonreactor personnel (June 1960) as compared to 52 $\mu\mu$c/g of potassium at the same time in England (*14*). The Cs^{137} body burden has its origin in world-wide fallout and is associated with ingestion of fallout-contaminated food, particularly milk (*11, 14*). A correlation was found in the present study between the amount of milk consumed by an individual and his Cs^{137}/K ratio.

The interest in Zn^{65} is not based on the radiation hazard that may result from its internal deposition, as even the highest levels detected in the reactor workers of group A were less than 0.1 μc, which is far below the maximum permissible concentration of 60 μc stated by The International Commission on Radiation Protection. Rather, the course of this isotope is interesting because it reveals how a radionuclide—in this case not a fission product, but an induced activity — moves through the food chain or through the atmosphere ultimately to deposit in man. It is of importance to establish baselines for unexposed populations for Zn^{65} and other radionuclides to provide data against which possible increases in body burdens may be measured. Fortunately, the current availability of whole-body gamma spectrometers makes feasible such general population studies. It is, of course, equally important in future studies to keep occupationally exposed personnel in nuclear energy establishments under close surveillance (*15*).

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Dielectric Constants and Molecular Interactions in Carbon Dioxide and Ethylene

Measurements at pressures from 1 to 100 atm have been made with sufficient precision to determine density dependent effects attributable to pair interactions of molecules in the two gases. For CO_2, the data show larger dielectric constant increases at 50°C than at 75°C and are satisfactorily explained by the induced polarization effect of a molecular quadrupole moment of about 5×10^{-26} esu cm^2, a figure in reasonably good agreement with other estimates. For ethylene, relatively large increases are also observed, but they increase with temperature in the range 25° to 75°C. This behavior is contrary to theories of quadrupole-induced dipole interactions, even when generalized to molecules lacking axial symmetry. These theories, however, either neglect quadrupole coupling energy or assume that it is small compared with kT. Calculations indicating that the effects of this energy are significant will be discussed, as will experiments which should further clarify the significant interactions between nonpolar molecules.

ROBERT H. COLE
D. R. JOHNSTON

Brown University

Linear Stark Effect in Magnetic Resonance Spectra

If a nucleus or paramagnetic ion with spin greater than one-half occupies a site in a crystal lattice without inversion symmetry, an externally applied electric field will cause, in general, a change in the quadrupole coupling constant or crystalline field splitting proportional to E.

The effect of deformation of the unit cell is additive to the explicit Stark effect at constant strain. The phenomenological description can be given in terms of tensors of third and fourth rank, which are similar to those used by Pockels for the description of the electro-optic and elasto-optic effects in crystals.

An individual ion or nucleus may occupy a site without inversion symmetry, even though the crystal as a whole has such symmetry and is not piezoelectric.

The magnitude of the linear Stark effect in ionic crystals can be readily estimated on the basis of the point charge model. The change in crystal field gradients due to relative displacement of the ions in an applied electric field should, for example, be observable for the nuclear quadrupole resonance of Cl^{35} in $KClO_3$ and for the electron spin resonance of Cr^{+++} ion sit-

uated near a vacancy in the MgO lattice. Kushida (private communication) has recently observed the effect, linear in E, on the quadrupole resonance of Br in $NaBrO_3$, although not at constant strain.

Effective g-tensors and higher order parameters in spin hamiltonians will of course also change linearly with E, if the ionic site lacks inversion symmetry. Such effects might be observable for rare earth ions in double nitrates.

If the electric field is varying at a frequency corresponding to resonance between a pair of spin levels, transitions may be induced at a rate proportional to E^2. This absorption can formally be described by an effective dielectric susceptibility, but this has, of course, nothing to do with the existence of an electric dipole moment. The strength of the electrically induced transitions, which may have $|\Delta m| > 1$, will be compared with the usual magnetic dipole transitions.

N. BLOEMBERGEN
Harvard University

Spark Chamber—Useful Detector for High-Energy Particles and Cosmic Rays

The spark chamber has recently come to the fore as a visual detector of high-energy particles. In the form developed by S. Fukui and S. Miyamoto [*Nuovo Cimento* **9**, 113 (1959)] the spark chamber consists of a multiplicity of plates in one atmosphere of neon gas, connected in such a way that the passage of a high-energy particle through the chamber triggers a circuit which puts a high voltage between alternate plates of the chamber. The voltage is high enough to produce sparks between the plates which occur preferentially along the path of the particle because of the ions which it produced there. The result is a series of bright sparks along the track of the particle which is easy to see visually. The importance of these detectors has been emphasized by J. W. Cronin and G. Renninger, and by Beall, Cork, Murphy, and Wenzel (Proc. Intern. Conf. on Instrumentation for High-Energy Physics, Berkeley, Calif., 12–14 September 1960), who have used these chambers successfully in a number of experiments with high-energy machines. A multi-plate spark chamber will be demonstrated which displays very nicely the μ-mesons of the cosmic rays. Some of the properties and applications of such a spark chamber will be discussed.

HERBERT L. ANDERSON
University of Chicago

Search for Microbial Causes of Common Illnesses

During a 3-year period, we studied 479 normal babies who lived for a week or longer under somewhat crowded conditions in a District of Columbia welfare institution. The population averaged 54 per week, the children averaged four admissions per week, and each child averaged 18 weeks of residence. Clinical observations included medical surveillance with rectal temperatures on each child every day. Laboratory observations included routine blood specimens and a search for microbial agents in throat and anal specimens collected from each child at least once a week.

Of 2823 febrile episodes observed, 1771 were classified as acute undifferentiated illnesses. Of the 4234 infections with 57 virus and 54 bacterial serotypes observed, 1502 virus and 703 bacterial infections were found in routine tests considered reasonably adequate for the specific agents. The study was designed so that illnesses and infections would be identified independently of each other by objective criteria. The frequency of definite undifferentiated illness during the week when a specific microbe was first isolated from children in routine specimens was compared (i) with the frequency of such illnesses in the same children during the two prior and two subsequent weeks, and (ii) with the frequency of illnesses in other children living in the institution during the weeks when new infections were occurring. At least eight virus and four or more bacterial serotypes were found significantly associated with the occurrence of acute undifferentiated illness. Serologic studies are now underway which make possible more precise analyses of such associations with more definitive end-points. To date, such analyses have not altered conclusions as to which agents were associated with illness.

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W. P. ROWE, L. ROSEN,
R. M. COLE, F. M. MASTROTA,
T. M. FLOYD, R. M. CHANOCK
National Institutes of Health

Encouraging Results in Long-range Weather Prediction

A comparison of the monthly precipitation at 32 cities, in 1959 and 1960, with a forecast from November 1956 is presented.

CHARLES G. ABBOT
Smithsonian Institution

Guided Propagation of Radio Waves in the Magnetosphere

The magnetosphere is the portion of the earth's outer atmosphere where collisions are so infrequent that the distribution of ionization-density is strongly influenced by the earth's magnetic field. In consequence, ionization is filamented in tubes along the earth's magnetic field, and guidance of electromagnetic waves around the tubes is possible. A theory of this guidance has been developed for the oversimplified situation in which there is a discontinuity of ionization-density across a surface formed by rotating a line of flux of the earth's magnetic field around the axis of the field. The theory is similar to that for a whispering gallery in acoustics.

The theory helps to explain the phenomenon of "whistlers." This is a phenomenon in which the electromagnetic pulse from a lightning flash is guided from one hemisphere to the other around the lines of flux of the earth's magnetic field and is thereby distorted into a descending whistle that may be detected at audio frequencies. Extension of the theory up to a radio frequency of 10 Mcy/sec suggests that propagation between the hemispheres around the lines of flux may be possible at frequencies above the penetration frequency of the ionosphere. Extension of the theory down to frequencies of the order of 1 cy/sec shows that hydromagnetic waves may also be guided around the lines of flux.

HENRY G. BOOKER
Cornell University

Two Metabolically Active Peptides from Pituitary Extract

As reported here in 1953, corticotropin was the most active pituitary principle evoking mobilization of fat in rats and mice. In the rabbit, however, Rudman has found that extracts depleted of recognized anterior pituitary hormones mobilize depot fat and induce lipemia. Material of this type has now been found in the acetic acid extract of porcine anterior lobes remaining in the manufacture of corticotropin with oxycellulose [*J. Am. Chem. Soc.* **73**, 2969 (1951)]. Neutralization of the 2.5 percent solution precipitated 80 percent of the solids. The active soluble fraction upon electrophoresis on starch gel at *p*H 8 showed that the most active material was represented by two rapidly moving anionic bands; the gel pattern guided purification. An impure mixture of the two peptides was recovered by adsorption on a minimal amount of Dowex 1-X2 acetate resin. They were retained by columns of this resin at *p*H 3.5 or above and eluted by gradients toward 0.1*N* acetic acid or toward stronger buffers of *p*H 3.5 to 4.0; peptide I, the slower moving on starch gel, emerged first followed by peptide II mixed with I. Both were retarded somewhat by Sephadex G-50, but peptide I was retarded more. Peptide II was more easily precipitated with trichloroacetic acid and could thus be obtained free of peptide I. In 1 ml of medium, .02 μg of the two peptides enhanced release of free fatty acid from leporine adipose tissue in vitro; 10 μg given intravenously trebled fatty acid in serum in 10 minutes; 1.5 mg induced gross lipemia in 12 hours, while larger doses were often lethal before lipemia developed.

E. B. ASTWOOD, R. J. BARRETT,
H. FRIESEN
New England Center Hospital and
Tufts University School of Medicine

Electron Microscopy of Deoxyribonucleic Acid Macromolecules in Solution

Electron microscope observations have been made of deoxyribonucleic acid (DNA) molecules under conditions approaching the native hydrated state by sandwiching a thin layer of DNA solu-

tion between impermeable ultrathin films in microchambers of special design and by using microbeam illumination of very low intensity [H. Fernández-Morán, *J. Appl. Phys.* **31**, 1840 (1960)]. In T2 bacteriophage DNA preparations thin fibrils about 30 to 40 μ long were seen formed by unit filaments of 20 A diameter in ordered lateral aggregation with indications of axial discontinuities of approximately 30 A. Oriented DNA fibers have also been mounted in vacuum-tight microchambers at controlled relative humidity in a form suitable for electron-diffraction studies. Irradiation with electron beams of higher intensity produces characteristic fragmentation of the filaments in wet DNA preparations, differing from the relatively stable appearance of the strands in dried specimens. With improved pointed filament sources and collimation devices, electron microbeam irradiation can be restricted to accurately defined regions of 100 to 1000 A along the fibrils. The described techniques provide the means for direct observation of radiation damage in selected macromolecular regions of hydrated biological systems under the electron microscope. This work was supported by a U.S. Atomic Energy Commission contract and by a grant from the National Institutes of Health.

HUMBERTO FERNANDEZ-MORAN
Massachusetts General Hospital and
Massachusetts Institute of Technology

Thermodynamic Potentials of Symmetrical Electrolytes

The Poisson-Boltzmann equation proposed by Debye and Hückel for the potential of a reference ion in an electrolytic solution has been integrated in two steps: in the first, the positive exponential function is explicitly retained, giving the potential accurately in the vicinity of the reference ion. By applying the conditions of continuity of potential and field at the distance $r = \epsilon^2/2\ D\ k\ T = \beta/2$ (the Bjerrum radius), this potential goes over smoothly into the Debye-Hückel potential, valid for large distances from the reference ion. The resulting limiting law for the thermodynamic potential for the case of point charges is of course unchanged, but for the sphere-in-continuum model, we find $-\ln f = \tau/(1+\tau)$, where f is activity coefficient and $\tau = \beta\kappa/2$ is a dimensionless rational independent variable determined by concentration, valence and the $D\ T$ product. The ion size a appears only in higher terms, the first of which has the functional form previously derived by the *ad hoc* hypothesis of ion association. The deviations between the above limiting expression for $\ln f$ and the experimental data are opposite in sign to those obtained by retaining further terms of the Poisson-Boltzmann equation; it is suggested that they can only be accounted for by extension of functions characteristic of the fused salt into and through the regions of high and moderate concentrations.

RAYMOND M. FUOSS, LARS ONSAGER
Yale University

Prophylactic Adrenalectomy for Advanced Breast Cancer

The condition of patients with carcinoma of the breast and wide-spread metastases, who have secured palliation from removal of the ovaries and adrenal glands, deteriorates quite rapidly when growth in the dormant metastases is resumed. Apparently, mutant malignant cells have appeared that can grow rapidly in the absence of the hormones of these glands. It would seem that the chance for such mutants to develop would be much greater when large masses of cancer cells are actively dividing than when the metastases are of small size. Twenty-four consecutive patients with recurrent cancer of the breast were treated by bilateral oophorectomy and adrenalectomy. Fourteen, or 58 percent, showed marked subjective improvement and survived for an average of 44 months. Seven patients are still living, an average of 60 months since adrenalectomy. The results secured in this series of patients are better than in some series reported by others. This may be in part because of the fact that adrenalectomy was carried out in a number of patients with minimal metastatic involvement. In one patient removal of the ovaries and adrenal glands was performed shortly after radical mastectomy. The specimen revealed a highly invasive tumor with involvement of most of the axillary glands and permeation of cancer cells into the lymphatics, blood vessels, and subcutaneous tissue. Distant metastases were not demonstrated, but were believed to be present. This patient has remained well without evidence of recurrence and has continued her usual activities for nearly 9 years. It is suggested that oophorectomy and adrenalectomy be employed as soon as metastatic lesions from breast carcinoma are diagnosed or are believed to be almost certainly present.

LESTER R. DRAGSTEDT
University of Florida

Biosynthetic Activation Accompanying the Transformation of Normal to Tumor Cell in Plants

The transition from normal to tumor cell must involve a major permanent switch in synthetic capabilities, going from a conservative, precisely regulated metabolism to one involving an increased synthesis of the nucleic acids, mitotic proteins, and other substances required specifically for cell growth and division. An understanding of the tumor problem would appear, therefore, to be concerned with a characterization of the cellular mechanism(s) responsible for this major permanent switch in synthetic metabolism. In studying this problem, a nonself-limiting tumor disease of plants known as crown gall was used as the experimental model. In this system the transformation of normal to tumor cell involves a gradual and progressive activation of a series of quite distinct but well-defined biosynthetic systems that represent the entire area of metabolism concerned with cell growth and division. The products of these systems include two intracellular hormones which act synergistically to promote growth and cell division, glutamine, meso inositol, as well as a purine and pyrimidine. The mechanism by which the entire area of metabolism concerned with growth and cell division becomes progressively and permanently activated during the transformation process has been studied further. Evidence has been obtained to indicate that certain of the biosynthetic systems shown to be unblocked in the plant tumor cell are ion-activated systems. This, in turn, suggests that changes in membrane permeability or ion-transport mechanisms accompany the cellular alteration, and, as a result of such changes, essential ions penetrate to the proper locus in a tumor cell where they activate certain essential biosynthetic systems.

ARMIN C. BRAUN
Rockefeller Institute

Electromagnetic Structure of the Proton and Neutron

New data have recently been obtained on the electromagnetic form factors of the neutron. These data are obtained by studying the inelastic electron-deuteron scattering at high energies. By using as normalization data the absolute cross sections known for the proton it is possible to find the absolute peak cross sections for the deuteron by experimental comparison of deuteron peaks and proton peaks. The modified Jankus theory is then employed to find the neutron form factors. The neutron form factors are considered together with the proton form factors as a body of data from which the structure of the proton and neutron can be deduced. We have developed four isotopic form factors which are taken as building blocks for proton and neutron form factors. The isotopic form factors are shown to be consistent with present experimental cross sections of the proton and neutron, including their rms radii. This formulation predicts that the neutron has a positively charged outer cloud. The neutron and proton are each composed of two Yukawa-type clouds having different ranges. Each particle also has a point-like core. Details of this attempted explanation will be given.

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Automatic Recording Techniques for the Chromatography of Peptides and Proteins

Before a fundamental understanding of the reactions in which proteins participate in living cells can be attained, we need to know the chemical structures of not one or two but many proteins of different origins and different functions. The

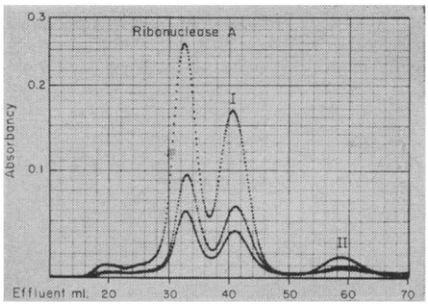

Fig. 1. Recorded chromatographic separation of ribonuclease A from the imidazole carboxymethyl derivatives on a 0.9 by 38 cm column of Amberlite IRC-50.

chemist is concerned with making the methods used for this purpose as expeditious as possible. It is proving feasible to place several of the principal analytical steps in a structural study on a recording basis. The equipment developed for automatic amino acid analysis is also being applied to a number of peptide separations. A tryptic hydrolysate of reduced and carboxymethylated ribonuclease can be effectively fractionated into the majority of its smaller individual components in a 7-hour run on a 15-cm column of Amberlite IR-120. The reproducibility of detail in the resulting effluent curves facilitates careful comparative studies of protein structures. The chromatography of proteins themselves can also be expedited in a number of similar ways, one of which is illustrated in Fig. 1 for the 120-minute separation of ribonuclease from alkylated derivatives.

STANFORD MOORE
ARTHUR M. CRESTFIELD
Rockefeller Institute

Rapid Induction of Mammary Cancers and Their Suppression

A single feeding of certain polynuclear hydrocarbons to healthy female rats of the Sprague-Dawley strain, age 50 days, evokes mammary cancer selectively, invariably, and rapidly. Whereas small mammary cancers are present 14 days after the feeding, the first visible cancer arose 20 days after the single meal. Ten hydrocarbons with this special carcinogenic property have been recognized; of these 7,12-dimethyl-benz(a)anthracene is the most effective, whereas 2-aminofluorene has the simplest structure.

In the carcinogenic process the following factors have been detected: absorption, transport, fit, and damage of selective sort. It is most probable that charge transfer of electrons is involved. Nucleoproteins are certainly a factor.

It is possible to accelerate the development of the breast cancers or to suppress them entirely. Pregnancy, at age 65 days, or the administration of progesterone solo enhances the development of mammary cancer in rats fed a single meal of DMBA at age 50 days. But the administration to their mates (which likewise had been fed the carcinogen at age 50 days) of estradiol-17β and progesterone at age 65 days, although it causes gestational development of the mammary glands, is a highly effective method of suppressing the young cancers. Cancers suppressed in this way never recurred—they were extinguished.

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

Mutagenic Effect of a 5-r Dose of X-Rays in Drosophila melanogaster

An experiment to examine the mutagenic effect of a dose of x-rays at a level comparable to the 30-year background dose received by human beings has been conducted during the past 2½ years. Minute bristle mutations, dominant mutations which occur at more than 50 loci in the *Drosophila* genome, serve as the basis of the scoring. The total experiment to date consists of a series of 40 repetitions of the experiment, each repetition consisting of identical numbers of control and irradiated cultures. Both parents are irradiated with 5 r, so that the effective dose to the offspring is 10 r, although each irradiated gamete has received only 5 r. Coding is used so that scorers are not aware of the identity of the irradiated cultures. Environmental variables and scoring variables are randomized insofar as possible. From dosage curves at 1000 to 2000 r and from assuming a linear proportionality of mutations to dose, the prediction was made that the increase in mutation rate would be 0.005 percent, in comparison with a spontaneous rate of 0.04 percent. To date, 585,927 individuals have been scored in the controls and 577,515 in the irradiated series, with 283 mutations in the controls and 323 in the treated series. The over-all control rate is 0.048 percent, or slightly above the prediction, and the difference (0.007 percent) is also a little greater than expectation. The difference lies at the 5 to 7.6 percent level of probability due to chance (depending on the criterion for exclusion of clusters). There is also a highly significant reduction in the number of progeny from the irradiated parents, amounting to 1.3 percent. Other visible mutations are also in excess, though not significantly. It may be tentatively concluded that an acute dose of 5 r produces mutations, at a rate linearly proportional to the effects at 1000 r and 2000 r, in the mature gametes of both sexes of *Drosophila*.

H. BENTLEY GLASS
REBECCA K. RITTERHOFF
Johns Hopkins University

Extreme Ultraviolet Light of the Night Sky Measured from Rockets

The Lyman-α glow of the night sky was first observed in 1955 and was then attributed to resonant scattering of solar radiation by neutral hydrogen in interplanetary space. Subsequent theories and spectrographic evidence have pointed to a geocoronal origin of the glow phenomenon, but do not eliminate the possibility of a small contribution from the interplanetary medium.

Helium is present in relatively high concentration in both the sun and interstellar space, whereas it is very scarce in the earth's atmosphere. Also, because of its relatively high ionization potential, a major fraction of helium may be expected to occur in the neutral and singly ionized states, in contrast to the case for hydrogen which must be almost entirely ionized. Recent measurements of the extreme ultraviolet solar spectrum show that the strongest emission lines are He I (584A) and He II (304A), both of which may be resonantly scattered by He I and He II in the interplanetary gas.

A search for a night sky glow in the He I and He II resonance lines was conducted from an Aerobee rocket in November 1960 with negative results. The experiment sets an upper limit of about 3×10^{-4} erg cm^{-2} sec^{-1} ster^{-1} on the intensity of any helium glow. This is less than 10 percent of the intensity of the hydrogen glow. The significance of this result in connection with the density of gas in the interplanetary medium will be discussed.

HERBERT FRIEDMAN
U.S. Naval Research Laboratory

Evolution at a Single Locus in Maize

The ancestral form of maize was probably pod corn, a type in which the kernels are enclosed in glumes as they are in other cereals. The genetic basis of pod corn is a locus on the fourth chromosome at which three alleles, *Tu*, *tu*^{h}, and *tu* are recognized. Six genotypes involving all combinations of these alleles have been compared in isogenic stocks. The genetic changes through this series from *TuTu* to *tutu* are accompanied by the following effects: (i) The tassel becomes less prominent and wholly staminate. (ii) The central spike of the tassel increases in size and the branches decrease in number. (iii) The ear increases in size and weight at the expense of the tassel. (iv) The rachis, the seed-bearing organ containing the system of supply, is enlarged and the glumes, which enclose the grains, are reduced. (v) The grains increase in size and number.

The weight lost in the tassels is accompanied by a gain of approximately fivefold in the ears. The middle position on the stalk of the corn ear apparently has both mechanical and physiological advantages over the terminal position characteristic of other cereals. This may account for the higher maximum yields of corn. In a simulated wild habitat, however, the ancestral form, pod corn, bears all of its seeds in the tassel and has a marked selective advantage over the genotype of cultivated corn. Consequently, evolution at this single locus has rendered the corn plant less able to survive in the wild and much more useful to man.

PAUL C. MANGELSDORF
HELEN P. MANGELSDORF
Harvard University

Charge Fluctuation Forces, Biological Specificity, and Replication

Because of charge fluctuation forces (in particular, London–van der Waals forces) molecules of several varieties, when immersed in a liquid, tend to rearrange themselves so as to bring molecules of identical types together as nearest neighbors. This comes about after Brownian motion has shuffled the molecules and introduced like molecules to each other. How strong is this effect and under what conditions is it significant? These questions are of importance in view of the phenomenon of crystallization and in view of their biological implications.

If two identical protein molecules contact each other, there may result an interlocking of corresponding pairs of identical side chains: sets of large amino acid side chains of the molecule interleaved, somewhat as the two halves of a zipper. This highly specific association may account for the synapsis of homologous chromosomes during meiosis (especially inverted synapsis). It may also account for the species-specific attachment between sperm and egg and for the organ-specific attachment between cell and the organ to which they belong. Primarily, it may be responsible for replica formation in the biosynthesis of proteins and nucleic acids by assembling its constituent filial monomers next to the given chain of parental monomers.

Biological specificity implies a great many mechanisms and different types of forces (as does crystallization). These are often in competition with each other so that in many instances it is steric compatibility, charge, or hydrogen bond complementarity which determine intermolecular attachment. In other cases charge fluctuation forces are the determining factors.

HERBERT JEHLE
George Washington University

Polyribonucleotide Synthetase

An enzyme isolated from the soluble cytoplasmic fraction of spinach leaves catalyzes the incorporation of the label of ATP-C^{14} into ribonucleic acid (RNA). This activity was purified approximately 60-fold. Little, if any, polynucleotide phosphorylase activity was detected by the specific P^{32}-ADP exchange assay for this enzyme.

Maximal incorporation of the radioactivity of ATP is obtained in the presence of all four ribonucleoside 5′-triphosphates, ATP, GTP, UTP, and CTP. Magnesium ions and RNA are essential requirements. However, RNA has to be combined with the protein prior to its addition to the reaction mixture. The addition of RNA, if not preceded by recombination, is ineffective. Deoxyribonucleic acid (DNA) cannot be substituted for RNA and the incorporation of ATP-C^{14} is not affected by the presence of deoxyribonuclease. With the enzyme recombined with tobacco mosaic virus and RNA, incubation for 4 to 12 hours with equimolar amounts of all four nucleoside triphosphates led to synthesis of RNA in 67 to 85 percent excess over the primer.

The above findings suggest that the enzyme is different from polynucleotide phosphorylase and also from recently reported enzymes in liver nuclei and bacteria that catalyze a DNA-dependent incorporation of nucleotides from ribonucleoside triphosphates into RNA.

K. K. REDDI
New York University School of Medicine

Broken Symmetries

A symmetry of one elementary particle interaction may be broken by another interaction. For example, the charge independence of nuclear forces (along with the equality of neutron and proton masses) is violated by electromagnetism. Recently it has been suggested that in some cases symmetries may exist that are badly broken, either by strong interactions or by rest masses. How then can we ever tell that the underlying symmetry is correct and applies to the "bare" masses and coupling constants? It is suggested that certain experiments at high energies and momentum transfers may permit the measurement of ratios of "bare" quantities and provide tests of broken symmetries.

MURRAY GELL-MANN
California Institute of Technology

Ion Distribution Patterns of Stationary State Systems

Upon consideration of a theory of coupled steady-state processes, a branch of the discipline of irreversible thermodynamics, it is possible to derive expressions for the steady-state ion-distribution patterns in the system phase α, transition zone, phase β which we take to be an idealized version of the biological system, internal environment, membrane, external environment. An outline of the theory in terms of the basic concepts employed and the details of an experimental test of the theory when a stationary state of the first order exists in the system will be presented. For example, when the system contains water, NaCl, and KCl, and when water is the only substance flowing through the membrane, the distribution function $(\Delta\mu_{Na} + \Delta\mu_{Cl}) / (\Delta\mu_{K} + \Delta\mu_{Cl})$ should be approximately equal to 1.2. Furthermore, it is found that when the external environment contains equal concentrations of Na and K ions and the water is flowing from the internal to the external environment, the internal environment contains a concentration of K ion about three times that of the Na ion. This research was carried out at Brookhaven National Laboratory under the auspices of the U.S. Atomic Energy Commission.

LESLIE F. NIMS
Brookhaven National Laboratory
ROBERT E. THURBER
Brookhaven National Laboratory
and *Adelphi College*

Enzyme Specificity in Activation and Transfer of Amino Acids to Ribonucleoprotein Particles

Two steps in protein biosynthesis are (i) activation and attachment of each amino acid to its specific acceptor RNA (S-RNA) and (ii) amino acid transfer from S-RNA to ribosomal protein. Each activating enzyme (involved in the first step) is specific for one amino acid and its S-RNA. Other enzyme(s) in the cytoplasmic fluid catalyze reaction (ii). This enzyme activity has been partially purified [D. Nathans and F. Lipmann, *Biochim. et Biophys. Acta* **43**, 126 (1960); R. Rendi, unpublished data].

We find that the amino acid–activating enzymes in cytoplasmic supernatants of yeast and rat liver catalyze the activation and transfer of leucine-C^{14} to both yeast and rat liver but not to *Escherichia coli* S-RNA. Reciprocally *E. coli* (and other bacterial) activating enzymes catalyze leucine activation and transfer to *E. coli* but not to yeast or rat liver S-RNA. The transfer enzymes in the cytoplasmic supernatant of yeast and rat liver catalyze transfer of leucine-C^{14} from S-RNA of various origins (yeast, rat liver, *E. coli*) to rat liver but not to *E. coli* ribosomes, and, reciprocally, the *E. coli* enzymes catalyze transfer to *E. coli* but not to rat liver ribosomes. Thus the transfer enzymes from bacterial or animal sources are specific for the corresponding ribosomes but not for the amino acid–S-RNA intermediates. Similar observations have been made independently by Nathans and Lipmann (personal communication). The transfer reaction to *E. coli*, but not to rat liver ribosomes, is inhibited by chloramphenicol or terramycin. These antibiotics appear to inhibit the bacterial ribosomes.

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Transport Equations of a Plasma

The transport equations of a plasma, however dilute, are given by

$$\frac{\partial f_1}{\partial t} + \boldsymbol{v}\cdot\nabla f_1 - \frac{e}{m_1}\left(\boldsymbol{E} + \frac{1}{c}\boldsymbol{v}\times\boldsymbol{B}\right)\cdot\nabla_v f_1 = \left(\frac{\partial f_1}{\partial t}\right)_{coll} = \frac{1}{m_1}\frac{c}{n}\boldsymbol{P}_{21} \qquad (1)$$

$$\frac{\partial f_2}{\partial t} + \boldsymbol{v}\cdot\nabla f_2 + \frac{e}{m_2}\left(\boldsymbol{E} + \frac{1}{c}\boldsymbol{v}\times\boldsymbol{B}\right)\cdot\nabla_v f_2 = \left(\frac{\partial f_2}{\partial t}\right)_{coll} = \frac{1}{m_2}\frac{c}{n}\boldsymbol{P}_{12} \qquad (2)$$

where I follow the notation of M. N. Rosenbluth and N. Rostoker [*Phys. Fluids* **2**, 23 (1959)], but supply an equivalent notation for the last terms.

The condition that there are equal and opposite charges per cubic centimeter of the two gases, the electron gas and the ion gas, with $Z = 1$, leads to the equation

$$n_1 \cong n_2 \cong n \qquad (3)$$

The condition that the convective change of momentum of the electron gas per cubic centimeter is equal and opposite

in sign to that of the positive ion gas per cubic centimeter leads to the equation

$$P_{21} + P_{12} = 0 \qquad (4)$$

and not that $P_{12} = 0$ and $P_{21} = 0$.

Assuming that m_1 is negligibly small compared to m_2, and using L. Spitzer's definition of the new terms [*Physics of Fully Ionized Gases* (Interscience, New York, 1956), pp. 20–21], but retaining $v_2 \cdot \nabla v_2$ in dv_2/dt I have Spitzer's two Eqs. 2-11 and 2-12 entirely equivalent to Eqs. 1 and 2. However, I retain $(c/en)P_{12}$, not replacing it by ηj, because I believe Spitzer's Eq. 2-13 is not applicable here.

Assume the term

$$\frac{m_0 c^2}{ne^2} \frac{\partial j}{\partial t}$$

is negligible in Eq. 2-12 of Spitzer and taking a two-dimensional symmetrical distribution of plasma within a long circular right cylinder, and assuming that E_θ is negligibly small, I find for the θ component of the force exerted by the relatively moving electrons upon the ions

$$P_{12\theta} = -\frac{ne}{c} v_{2r} B_z$$

This force, which is neglected by most theoreticians, makes the containment time of the enclosed plasma independent of the magnitude of the magnetic field.

The so-called "magnetic bottle" for retaining a hot plasma from a cold wall is but a fantastic dream.

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Evaporation Resistance as a Sensitive Measure of the Purity and Molecular Structure of Monolayers

This report is a continuation of our studies on monolayers [La Mer and Barnes, *Proc. Natl. Acad. Sci. U.S.* **45**, 1274 (1959)].

Before undertaking temperature-coefficient studies, the reproducibility of evaporation-resistance measurements required further examination. Samples purified for laboratory studies and also commercial materials or mixtures for practical application on reservoirs have been examined. A number of the evaporation resistance-surface pressure curves reported in the previous work have been confirmed—in particular those for pure octadecanol, hexadecanol, and stearic acid. The extreme sensitivity of evaporation-resistance measurements to the presence of minute amounts of impurities is illustrated by these results. Such measurements on samples purified by different methods indicate appreciable differences in purity which are not apparent from melting-point determinations. The effects of impurities predominate at low surface pressures, yielding abnormally low values of evaporation resistance accompanied by poor reproducibility. At higher pressures these effects are less significant because of the impurities being squeezed out of the monolayer. Also a higher degree of reproducibility can be obtained for a given specimen. The squeezing out of impurities is time-dependent, which is evidenced by an increase in evaporation resistance when the monolayer is maintained under pressure. The variability observed at lower surface pressures (< 15 dy/cm) is now attributed to uncontrollable differences in the rate at which minute amounts of contaminants or of solvent are squeezed out.

The behavior of the monolayers under pressure as a function of time provides a criterion of the purity and rearrangement of molecular structure. In general, higher purity results in greater stability under compression.

The resistance to evaporation through monolayers of a particular chain length is determined primarily by the nature of the polar head group and its influence on compressibility of the monolayer through packing of the hydrocarbon chains. The region of relative independence of evaporation resistance upon surface pressure observed for compounds with a divided head group in the liquid-condensed phase is attributed to a rearrangement of the polar head groups before the transition to the solid-condensed phase.

VICTOR LA MER, L. A. G. AYLMORE
Columbia University

Classification of Clusters of Galaxies

A classification of clusters of galaxies by means of the forms of the brightest members is outlined. The form types of the individual component galaxies are based on a system that I devised earlier. The principal parameter of this system is a measure of the average stellar constituents of the brighter, inner parts of the individual galaxies.

The classification system for clusters of galaxies is applied to the nearest clusters of Abell's catalogue. The results indicate a remarkable uniformity in the stellar population of the brightest galaxies in different clusters.

W. W. MORGAN
Yerkes Observatory, University of Chicago

Aid to Music Composition with a Random-Probability System

The art of music composition can be learned to some extent by following the work of composers combined with a knowledge of the fundamentals of music. Composition can be stimulated by various experiences and may be aided by research. However, the process which operates in the mind of the composer is not understood. Even without such knowledge, it is possible to develop machines which can aid the composer in his search for melody, which is the essence of most music. The ability to create is a gift. Nevertheless, even great composers have at times turned to mechanical aids for assistance. In this connection, random-probability systems allow the generation of sequences of notes in a series which are not completely random nor completely ordered, but each note is selected in a random fashion with a probability which depends upon preceding notes. Such a machine has been developed and has been operated to generate a sequence of an almost infinite series of notes according to trinote probabilities found in the music of Stephen Foster. Combined with sound synthesizers, the machine provides additional instrumentation for the musical laboratory. However, the ultimate output of even the best-equipped laboratory still depends upon the composer.

HARRY F. OLSON, HERBERT BELAR
R.C.A. Laboratories

Optical-Maser Oscillations in a Gaseous Discharge

The use of a gaseous discharge for obtaining a medium to amplify electromagnetic radiation at an optical frequency will be discussed [A. Javan, *Phys. Rev. Letters* **3**, 518 (1959); A. Javan, in *Quantum Electronics*, C. H. Townes, Ed. (Columbia Univ. Press, New York, 1960)]. Particular emphasis will be given to the case of a gaseous discharge consisting of a mixture of He and Ne, in which the predominant mode of excitations of several excited states of Ne is achieved by means of inelastic collisions of He(2^3S) metastable and Ne atoms. This system has been used [A. Javan, W. R. Bennett, Jr., D. R. Herriott, *Phys. Rev. Letters* **6**, 3 (1961)] to achieve continuous-wave optical-maser oscillations at several frequencies in the near infrared. The short-term stability of the maser oscillation is better than one part in 10^{11}. The coherence and directionality of the output of the maser and some of its applications will be discussed.

A. JAVAN
Bell Telephone Laboratories

Report on the Free Oscillations of the Earth

Free oscillations of the earth have been observed after two earthquakes. Comparison of observed frequencies with theoretical predictions shows excellent agreement. Investigators from the California Institute of Technology, Columbia University, University of California at Los Angeles, and Weizmann Institute are associated with this initial work.

In addition to deducing the properties of the earth's interior from the frequencies of the various modes and the Q of the oscillations, other experiments occur to us. Information concerning the earthquake mechanism can be obtained from phase relationships. Searches can be made for oscillations excited by sources other than earthquakes with improvements in signal-to-noise made possible by prior knowledge of the natural frequencies.

New instrumental approaches involving both strain and pendulum seismographs with digital outputs are being made.

FRANK PRESS, HUGO BENIOFF
Seismological Laboratory,
California Institute of Technology

Concerning a Free Mode of the Earth's Inner Core Possibly Observed during the Chilean Earthquake

The solid inner core of the earth may theoretically execute a rigid-body vibration within the surrounding fluid outer core under excitation by a large earthquake. The gravitational effects of the associated displacements were possibly observed by a LaCoste-Romberg earth-tide gravimeter after the Chilean earthquake of last May. The nature of this gravitational evidence is discussed. Assuming for purposes of discussion that the observations are valid, the free-period (86 minutes) is about 50 percent less than would be expected if only gravitational restoring forces were operative. The required magnitude and nature of additional restoring forces is discussed. The low time-rate of decay of the vibration indicates that the energy dissipation in the material of the fluid outer core is surprisingly low.

LOUIS B. SLICHTER
University of California, Los Angeles

Many Electron Theory of Atoms and Molecules

To predict the chemical and spectroscopic properties of atoms and molecules, correlations in the motions of electrons must be taken into account. So far this has been done successfully only in two electron systems, for example, He and H_2. In larger systems the motions of progressively two, three, four, . . . electrons at a time can be considered as in the theory of imperfect gases. However, the numbers of triplets, quadruplets, and so fourth, increase much faster than the number of pairs as the total number of electrons increases. Our theory reduces this many electron problem to several He- or H_2-like problems by showing why three, four, and larger numbers of electron correlations should be small. Only pairs are needed. Any two electrons, while moving in the "sea" of all the others, affect one another through a correlation potential which is of short range. The "sea" acts on the pair through its Hartree-Fock potential. The theory does not depend on any perturbation expansion. Any pair-wave function can be obtained by minimizing a simple expression just as in He or H_2. The validity of the theory is demonstrated on Be and LiH.

OKTAY SINANOGLU
Yale University

A Requirement for Genetically Specific DNA in the Cell-Free Synthesis of the Enzyme β-Galactosidase

A cell-free system, from pre-induced cells of *Escherichia coli* consisting of particles and supernatant from centrifugation at 105,000 *g*, catalyzes the *de novo* synthesis of β-galactosidase [T. Kameyama and G. D. Novelli, *Biochem. Biophys. Research Communs.* **2**, 393 (1960)]. When the system is properly supplemented with inducer, amino acid, a source of energy, and nucleoside di- and triphosphates, it is capable of effecting a two- to fourfold increase in enzyme activity. A striking inhibition of enzyme synthesis occurs in the presence of deoxyribonuclease. A similar inhibition is seen when the supernatant is exposed to sound waves or ultraviolet light or both. This inhibition can be overcome by the addition of DNA from normal supernatant. X-irradiation of pre-induced cells also inhibits further enzyme synthesis. Mixed experiments with particles and supernatants from normal and x-rayed cells showed that x-irradiation had damaged a component of the supernatant. This component could be replaced with DNA from normal supernatant, and enzyme synthesis in the cell-free system was completely restored. DNA from pre-induced cells of the inducible strain or from the uninduced constitutive mutant restores enzyme synthesis to the cell-free system from x-irradiated cells. DNA from uninduced cells or from a lactose-negative mutant (lacking the gene for β-galactosidase) as well as DNA's from other sources are completely ineffective in the restoration of x-ray damaged enzyme synthesis. These experiments as well as those with different types of DNA will be presented, and the significance of the results will be discussed with respect to the mechanisms involved in induction and repression.

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Oak Ridge National Laboratory
T. KAMEYAMA
National Institute of Radiological Sciences, Japan

Relationship of Structure to Activity of Ribonuclease

The availability of a working hypothesis for the chemical structure of bovine pancreatic ribonuclease has encouraged efforts to understand the specific features of the molecule which endow it with catalytic activity. Chemical alterations that cause inactivation have been used by a number of investigators for this purpose. Iodoacetic acid has been a particularly useful reagent. At *p*H 6, alkylation of a single one of the four histidine residues of ribonuclease occurs with the formation of one major, inactive derivative. From the work of W. D. Stein and Barnard [*J. Mol. Biol.* **1**, 339, 350 (1959)], it may be assumed that the residue involved is the histidine at position 119. Crestfield has found that the reaction is specifically oriented toward the nitrogen atom in the 1-position of the imidazole ring of this histidine. The alkylation is abolished by inhibitors of enzymic activity, such as cytidylic acid or cupric ion, and by procedures which alter the tertiary structure of the molecule, such as rupture of the disulfide bonds or exposure to denaturing agents. For these reasons, the histidine residue at position 119 has been placed at the "active site" of the enzyme. Special characteristics of this histidine reaction suggest that a second histidine residue is also involved at the active site. Studies by Anfinsen [*J. Biol. Chem.* **221**, 405 (1956)], Richards and Vithayathil [*Brookhaven Symposia in Biol. No. B* (1960)], and Hirs *et al.* (Proc. Symp. on Biological Structure and Function, Stockholm, 1960) make it probable that the aspartic acid residue at position 121, the asparagine residue at position 15, and the lysine residue at position 41, may all also be at or near the active site. Thus, by the discriminating use of chemical methods, the nature of the active site and certain aspects of the three-dimensional folding of the molecule are slowly being revealed.

WILLIAM H. STEIN, GEORGE R. STARK
Rockefeller Institute

The Extreme Ultraviolet Spectrum of the Sun

The character of the solar spectrum in the extreme ultraviolet is now fairly well known and much can be said about the origin of these radiations. The general picture is of ultraviolet radiation emitted from regions higher in the atmosphere, the shorter the wavelength. Short of 2085 A the Fraunhofer lines fade and become replaced by emission lines. The continuum extends at least to 800 A; from 1400 to 1280 A its brightness temperature is 4700°K. Hence in this spectral range it must originate near the temperature minimum between the photosphere and the chromosphere. From 1280 to 800 A the spectrum is dominated by the Lyman series of hydrogen. Lyman-α is intense, 1-A broad at half-maximum, strongly self-reversed, and with broad damping wings which merge into the continuum within 60 to 100 A. A faint continuous background extends through the entire Lyman series, whose members are resolved through kappa, and is followed by the Lyman continuum, at 6600°K brightness temperature and detectable to 800 A. Most of about 200 emission lines are identified. They are the lines of greatest laboratory intensity, of the most abundant light elements in the sun through sulfur, in states of ionization as high as the eleventh. The lithiumlike isoelectronic sequence is especially complete, with the resonance lines of C IV, N V, O VI, Ne VIII, Mg X, and Si XII, distributed down the spectrum from 1548 to 499 A, forming a sequence whose origins ascend from the low chromosphere into the corona.

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U.S. Naval Research Laboratory

Development of Gaseous Masses of Lunar Mass

It has been postulated that a solar nebula existed having a mass of about one-third $M_\odot$ and that this broke up into a large number of spherical masses of the order of that of the moon plus its cosmic gases. Such masses would contract because of the loss of energy and mass and would develop various pressures and temperatures

on their interiors. Ideal gas laws have been used in the past to estimate these temperatures and pressures as functions of the mass and radius. In this paper a progress report on the treatment of such spheres by using the current estimates for the nonideal gas laws for hydrogen-helium mixtures will be given. The relation of these calculations to current suggestions regarding the origin of meteorites and planets will be discussed.

H. C. UREY, JANET BAINBRIDGE
University of California, San Diego

On The Participation of Deoxyribonucleic Acid in Ribonucleic Acid Biosynthesis

An enzyme system, first observed by this laboratory in rat liver particles and now found in a number of different organisms, has been described for the biosynthesis of ribonucleic acid. The reaction catalyzed by this enzyme is specific in that it requires the presence of all four ribonucleotide triphosphates as well as DNA. Because of the importance of DNA as an agent of genetic information, it was necessary to gain some insight as to the role played by DNA in this reaction.

With a partially purified enzyme prepared from extracts of *M. lysodeikticus,* RNA was synthesized, in vitro, in the presence of a number of DNA's isolated from various sources. Analysis of the RNA formed showed that with different DNA's the relative position of one ribonucleotide next to its neighbor nucleotide was altered. This information suggested that, in this DNA-requiring reaction, the sequential arrangement of bases in DNA was influencing the arrangement of bases assembled in the RNA molecule. Furthermore, when the base composition of the newly synthesized RNA was determined, it appeared very similar to the base composition reported for the various DNA's used. The data suggest that, in the presence of a specific DNA, it is possible that this enzyme will synthesize complementary ribopolynucleotides.

SAMUEL B. WEISS
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Electricity as Lines of Force Trapped by Topology

The standard equations of Einstein for general relativity and of Maxwell for the electrodynamics of charge free space can be rephrased (Rainich and Misner) in a form that makes no reference to any quantities other than geometrical. The resulting "geometrodynamics" provides a model for the physical world built upon curved empty space—and its dynamical evolution with time—and nothing more (i) which presumably—even after quantization—cannot predict the properties of elementary particles but (ii) which even at the classical level is richer by far in consequences than any nongeometrical theory of physics. Without any inventions or changes it predicts (i) the equations of motion of concentrations of mass-energy (Einstein-Infeld-Hoffman), (ii) the ability of certain kinds of concentrations of electromagnetic and gravitational wave energy (geons) to hold themselves together—as objects endowed with mass—for long periods of time under their own gravitational attraction, and (iii) the existence of equal and opposite charges under circumstances when lines of force are trapped in the topology of a multiply connected space. Nowhere inside of these masses and charges is there anywhere where one can put his finger and say here there is "real mass" or "real charge." Nor is there any evidence that these pencil and paper constructs—of macroscopic size—have the slightest direct connection with the world of elementary particles. However, it is difficult to escape the conclusion that the geometrodynamic type of electric charge can be created under extreme conditions of space curvature ("point A") if general relativity is correct. It is also unreasonable to postulate two kinds of electricities—one geometrical, the other some kind of magic jelly—when economy of concepts would seem to demand a single explanation for electricity. On this basis it would appear difficult to escape from the conclusion that *all* electricity arises from trapping lines of force. The evidence on point A will be reviewed. The absence of *magnetic* charges ("point B") will be discussed in connection with the existence of the electromagnetic four-potential.

JOHN A. WHEELER
Princeton University

Present Status of the Juvenile Hormone

The corpora allata of insects are known to be the source of a "juvenile hormone" which opposes or prevents insect metamorphosis. The presence of the juvenile hormone in the blood and tissues of the immature insect causes growth to proceed without metamorphosis. The hormone is therefore a conservative factor which blocks "growing up" without interfering with growth in an unchanging state.

Five years ago the first active extracts of juvenile hormone were prepared from the abdomens of adult male *Cecropia* moths. Subsequently, the hormone has been subjected to extensive purification. Preliminary infrared and nuclear magnetic resonance studies suggest that the active principle is a water-insoluble lactone rich in methyl and methylene functions.

The vast majority of mammalian tissues contain low concentrations of a substance which is indistinguishable from the juvenile hormone when purified and tested on insects. The most active extracts have been prepared from the thymus and adrenal cortex of calves, and from human placentae. Thus far, nothing is known about the biological activity of the juvenile hormone in mammals or other vertebrates; studies of this type will presumably become feasible after the hormone has been characterized and synthesized.

According to my recent findings, the action of the juvenile hormone on the cells and tissues of insects is associated with its ability to block the de-repression and decoding of fresh genetic "information" without interfering with the use and re-use of information already at the disposal of the cells. Therefore, the hormone favors growth in an unchanging state. This study was supported in part by a grant from the Division of General Medical Sciences of the National Institutes of Health.

CARROLL M. WILLIAMS
Harvard University

Quantum Mechanical Measurements

The theory of quantum mechanical measurements was formulated most precisely by von Neumann. According to his ideas, the theory consists in the establishment of a statistical correlation between the state of the object on which the measurement is taking place and the state of the measuring apparatus. The "reading" of the apparatus consists in determining in which of several possible states the apparatus is; the statistical correlation between apparatus and object after the measurement is such that the state of the apparatus determines the state of the object, and that this latter state is one of the eigenfunctions of the operator which is being measured. It has been shown some time ago that only those operators can be measured precisely in this way which commute with all additive conserved quantities, such as the components of the angular momentum. As a result, we find that there are, from the point of view of measurability, three types of quantities. The precisely measurable quantities's operators commute with all additive conserved quantities; the collision matrix belongs to this category. Most quantities can only be measured approximately, the possible degree of approximation increasing with the measuring instrument's content of the conserved quantities. Finally, there are quantities which cannot be measured at all; this gives rise to the so-called superselection rules.

E. P. WIGNER, M. YANASE
Princeton University

Some Recent Results in the Study of Molecular Structure

Microwave spectroscopy has been applied to the determination of the detailed quantitative structure and other properties of increasingly complicated molecules. Molecules showing several forms differing by internal rotations can now be treated. In addition, energy barriers to internal rotation, dipole moments, nuclear quadrupole coupling constants, and other properties can be obtained with a new degree of detail. Thus not only the magnitude but the direction of dipole moments as well as their dependence on vibrational state and isotope substitution can be determined. Barriers to internal rotation can be used to gain new insight into nonbonded forces. Results will be discussed for a number of recently studied molecules.

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