

clear experimentation. There exist nuclear emulsions which can detect electrons, mesons (several types of which were discovered through their use), protons, and heavier nuclei.

Since nuclear emulsions reveal the passage of the particle by means of the developed grains, they give a picture similar to that obtained with a cloud chamber. There are, however, important differences: the emulsion is continuously sensitive, requires no moving parts, and its high density, furthermore, makes for much greater sensitivity per unit volume. In consequence, it is ideally suited to situations in which time resolution is not required. Its high specific sensitivity makes the collection of track data rapid, thus simplifying the experimentalist's problem of keeping conditions constant during exposure. The emulsion technique has the obvious drawback associated with arduous microscopic analysis of the plates.

One application has been to measure neutron spectra by observing the tracks of proton recoils originating in the emulsion. Some investigations have been made of the high energy limit of the emulsions used in this manner. The investigation reported here attempts to determine the low energy limit on neutron spectra which can be studied quantitatively by means of this technique. The essential result is that Ilford type C2 emulsion can be used reliably down to 500 kilovolts and with reasonable precision down to 300 kilovolts if suitable corrections are applied. A reason for this limitation can be found in the small number of grains, less than five, rendered developable by lower energy recoil protons, and the probability that an intermediate grain can be missing and so make difficult the identification of a track.

It might be hoped that the low energy limit can be decreased somewhat by further reducing the developable grain size.

F.R.

Nuclear Emulsions and the Measurement of Low Energy Neutron Spectra. By N. Nereson and F. Reines. *Rev. Sci. Inst.*, 21: 534, June, 1950.

■ Geomagnetic Cosmic Ray Effects

For many years data have been collected on the intensity of cosmic rays at numerous places on the earth, both at sea level and at high altitudes. Experimentally the following four effects have been found and identified with the influence of the magnetic field of the earth; the latitude effect, the longitude effect, the east-west effect, and the azimuthal effect.

The latitude effect presented strong evidence that a majority of the energy in the primary cosmic rays is in charged particles with individual energies up to 17 billion electron volts (Bev); the longitude effect fitted in with the known eccentricity of the equivalent dipole field of the earth; the east-west effect gave evidence that positively charged particles predominated over negatives in the energy range 10 to 30 Bev; the azimuthal effect at intermediate latitudes gave further evidence on the ratio of negative to positive particles in the primary radiation.

Data taken recently in a B-29 airplane, flying at a constant pressure altitude of 30,000 feet from 64° geo-

magnetic north to the geomagnetic equator, combined with data taken on the azimuthal effect at various zenith angles at 36,000 feet above the equator, have now made it possible, with the help of calculations of Lemaitre, Vallarta, and others, to establish experimentally the dependence of the minimum momentum a charged particle must have to reach the earth at a given latitude in the east-west plane. This has been done for the vertical, at 45° east, and at 45° west. Such information is important particularly at intermediate latitudes where the detailed calculations have not in general been carried through.

The above correlations are possible only if the number of primary negative particles is negligible compared with the positives and is taken as strong evidence that negatively charged particles in the energy range here dealt with are entirely absent or produce negligible effects in the atmosphere.

H.V.N.

Correlation of Geomagnetic Cosmic-Ray Effects. By H. V. Neher. *Phys. Rev.*, 78: 674, June 15, 1950.

■ Polystyrene, Warm and Cool

This investigation represents an attempt to understand why noncrystalline rubber-like polymers suddenly lose their flexibility and become brittle when cooled to a particular temperature, and conversely why an amorphous plastic such as polystyrene when heated to a particular temperature suddenly becomes either flexible and rubbery or fluid.

Specific volumes and liquid viscosities were measured versus temperature for polystyrene of different chain lengths. The so-called second order transition was identified as the temperature T_g at which the thermal expansion coefficient changes abruptly. The viscosity-temperature coefficient furnished a measure of the internal mobility of the liquid polymer. The embrittlement of amorphous polymers below T_g is analogous to the formation of low molecular weight glasses. The mobility of segments of the polymer chains necessary for volume equilibration and elastic or viscous deformation decreases continuously with decreasing temperature as the configurational arrangement of nearest neighbor segments becomes more compact. This mobility becomes so small at T_g that the local liquid structure is kinetically frozen in. Decreasing the polymer chain length lowers T_g in proportion to the concentration of chain ends thus introduced; this is due to a disruption of the liquid structure by the chain ends.

The chief results emphasize the importance of the local configurational structure of the liquid polymer in determining its properties. No quantitative description of this structure is possible at present.

P.J.F.

Second-Order Transition Temperatures and Related Properties of Polystyrene. I. Influence of Molecular Weight. By Thomas G. Fox, Jr. and P. J. Flory. *J. Appl. Phys.*, 21: 581, June, 1950.

■ The Polystyrene Molecule

This paper is the report of an intensive study of the molecular properties of a typical high polymer, polysty-

rene, using the newly popular light scattering method. The polymer is dissolved in suitable organic solvents and the intensity and angular distribution of the light scattered by the dispersed molecules are studied and interpreted in ways similar to well established techniques of x-ray analysis. The present work is the most nearly complete study to date of a single material by this method.

Quantitative data were obtained on several poorly understood effects, such as the curling and contraction of the polymer chains in poor solvents and on the deviations of the solutions from the ideal solution laws. It is expected that such quantitative relations will be of value in testing theories of solutions. A controversial point was raised by the fact that the data can only be understood if the polymer chains are assumed to carry very few, if any, branches.

B.H.Z.

Light Scattering Investigation of the Structure of Polystyrene. By P. Outer, C. I. Carr, and B. H. Zimm. *J. Chem. Phys.*, 18: 830, June, 1950.

■ New Spectrometer

Three of the most important characteristics of a nuclear spectrometer are its resolving power, its transmission, and its cost of construction. High resolving power is necessary for accurate measurements of beta ray and gamma ray energies and for the precise determination of the shapes of beta ray spectra. High transmission is desirable in order that adequate counting rates can be obtained from thin sources. However, the desire for a spectrometer having these properties is all too often outweighed by the need for economy.

The present paper describes a relatively inexpensive spectrometer designed for use in making detailed studies of beta ray and gamma ray disintegrations. The instrument is patterned in many respects after a much larger version built by Langer and Cook. A comparison of the two spectrometers yields the following points of interest: for one thing, both instruments employ a shaped magnetic field in order to obtain higher order focussing; for another, they display comparable resolving power and transmission; and finally, because of the reduced size of the present instrument, its cost should be within the means of smaller institutions.

J.A.B.

A High Resolution Beta Ray Spectrometer. By Joseph A. Bruner and F. R. Scott. *Rev. Sci. Instr.*, 21: 546, June, 1950.

■ Mathematical Biophysics

Steady state kinetics of biological systems continues to be developed by John Z. Hearon along the lines suggested by the concept of flux applied to thermodynamic quantities. In particular, Dr. Hearon, in his third paper on the subject, discusses the flux of free energy through biological systems both in steady and in time dependent states and brings out the important differences involved. Dr. Hearon also distinguishes between free energy flux and the conventional free energy exchange. Such questions were already raised by A. J. Lotka who posed the problem of maximizing the energy which an organism derives

from its environment and puts to favorable use. In a way, this focuses the attention on a new concept of biological efficiency which is emerging from similar studies.

In his fourth paper on the subject, which appears in the same issue, Dr. Hearon examines the irreversible production of entropy in diffusion fields and as a result of chemical reactions. Certain "type-systems" are postulated and rates of change of free energy and entropy are indicated. Some consequences of Onsager's generalization of Fick's Law are discussed in terms of maintenance of stationary, nonequilibrium concentration distributions, transport of a solute against a concentration gradient, and the dependence of these phenomena upon metabolism.

Mathematical radiobiology is represented by two papers. One by I. Opatowski and Alice M. Christiansen is concerned with the single event hypothesis in radiogenetics. It is shown that the assumption of a cumulative action of many independent random events as a primary cause of induction and mutation fits the experimental data at least as well as the single event hypothesis. The other paper, by H. G. Landau, treats the problem of diffusion and recombination of ions due to the passage of an ionizing particle. It is assumed that as a result of the passage of a single such particle, ions and their products are distributed with cylindrical symmetry around the path. Ion diffusion and recombination is taken into account where diffusion is the more important factor. A perturbation method is applied to the problem.

A mathematical theory based on probabilistic considerations is offered by H. D. Landahl to account for data obtained in experiments on the retention and removal of airborne droplets in the human respiratory tract. Previous results by W. Findeisen are extended and, to some extent, modified. In addition to providing a theoretical basis for observations, the theory gives some indication as to where in the respiratory tract the particles may be expected to be retained.

In his third paper on the probabilistic approach to animal sociology, A. Rapoport introduces bias factors into the theory of the origins of different "social structures" based on peck right. In particular it is shown how under certain assumptions it is possible to calculate a relation between the importance of some inherent "ability" in establishing peck right relations and the initial probability of a simple chain structure. The extreme case where the "inherent ability" is completely decisive in establishing peck right leads, of course, to the certain initial emergence of a simple chain; while the opposite extreme, where peck right is determined by pure chance, reduces to the cases treated in previous papers.

Three short notes complete the issue: N. Rashevsky's on Landahl's theory of psychophysical discrimination; H. D. Landahl's on a mechanism of the distribution of wealth; and G. Karreman's on the glycolytic coefficient of a cell as a function of the external concentrations of glucose, lactic acid, and oxygen.

A. Rapoport

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