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° geomagnetic 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 Lemaître, 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. App. 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-