PHYSICS

Chairman: GEORGE D. VAN DYKE, Earlham College
FRANCIS E. THROW, Wabash College, was elected chairman for 1955

ABSTRACTS

On Non-Equilibrium Carrier Concentration in Ge. RALPH BRAY, Purdue University.—Deviations from equilibrium concentration of carriers in a Ge sample may be produced by passing current through the sample. The contacts to the sample are of primary importance in this effect. Depending on the method of making the contact, it is possible to produce situations where the minority carrier concentration at the contact is *greater* or *less* than in the interior. Passing current through the sample with the given contacts sweeps either an *excess* or *deficiency* of minority carriers into and through the sample. There is a consequent decrease or increase in sample resistance. The processes are respectively labeled injection and extraction. Control of the carrier concentration by the current, leads to control of sample resistance and of rectifying contacts, e.g. as in transistor action. Transient recovery after injection or extraction is by recombination or thermal generation of hole-electron pairs. The rate of reaction is characterized by the "lifetime."

On the Thermodynamics of Crystalline Lattices. LEWIS S. SALTER, Wabash College.—The computational problems involved in the quantitative discussion of the thermodynamics of ideal crystals are briefly reviewed; a general result is derived, based on a lemma established by Born[1], which materially simplifies the theory. It is shown that the Helmholtz free energy (and thus the other thermodynamic functions of interest) of the harmonically vibrating lattice is obtainable as the average over reciprocal space of the trace of a function of the dynamical matrix, without recourse to the normal mode distribution function $g(\omega)$.

On the Formation of Oxide Films on Chromium and Nickel-Chromium Steels in Air at 500° C. to 700° C.[2] H. J. YEARIAN, J. F. RADAVICH and W. D. DERBYSHIRE, Purdue University.—A uniform polycrystalline film of oxide 100 to 500 A in thickness forms in the first few minutes of oxidation and grows very slowly thereafter. As oxidation proceeds the protectiveness of this base film fails at random positions and at random times, leading to the local formation of nodules of oxide which represent the majority of the metal loss. Those nodules grow and new ones continue to form until the whole base film is covered with a relatively heavy deposit constituting an incipient scale. The rate at which the process proceeds depends on alloy composition and temperature in the same way as does the scaling rate at higher temperatures.

1. BORN, M. 1943. Theoretical investigations on the relation between crystal dynamics and X-ray scattering. Rep. Progr. Phys., 9, 294.

2. Supported by the Office of Naval Research and by Project Squid, jointly sponsored by the Office of Naval Research and the Office of Air Research.

The composition and preferred orientation of the film and nodules will be discussed.

On the Effect of Reduction on the Low Temperature Heat Capacity of Rutile. P. H. KEESOM and N. PEARLMAN, Purdue University.—The molar heat of pure rutile (TiO_2) has been found to be proportional to T^3 in the liquid helium region, with a Debye $\Theta = 758°$ K., assuming 9N degrees of freedom. In the liquid hydrogen region, Θ decreases, reaching 460° K at 20° K. After slight reduction at 1000° C., the heat capacity in the liquid helium region increases greatly. Re-oxidation shows this effect to be approximately reversible. The increase also depends on the degree of reduction. The additional heat capacity appears to be constant from 1° to 13° K., and then to decline to zero by 16° K. Reduced rutile is a semiconductor in which the electrons have a very high effective mass. A possible explanation of the observed increase is that each "free" electron contributes its classical value, 3k/2, to the heat capacity.

On Varieties of Nuclear Shell Model. DAVID C. PEASLEE, Purdue University.—The nuclear shell model has several variations: j-j coupling versus L-S, single-particle versus collective states. The L-S coupling appears mainly in light nuclei, the collective states in heavy nuclei, and the j-j single-particle model has some applicability throughout the entire periodic table.

A survey will be given of present evidence on each of these variant models and their range of validity.

On a Fast Cycling Cloud Chamber. FRANK S. MATHEWS and HALSEY L. ALLEN III, Purdue University.—In order to make better use of the γ-ray beam from the Purdue 300 Mev synchroton, the 14″ cloud chamber has been modified for fast cycling. By overcompressing the chamber quickly after fast expansion, the gas is heated up and the droplets are vaporized so that the chamber is ready for another exposure. It has been possible to decrease the cycle time to 7 seconds although operation is better at 12 seconds. This is to be compared with the 60 second cycle used before. Although there are still some problems of turbulence, clear pictures are obtained.

The cloud chamber is being used at the present time to study the production of mesons by the 300 Mev γ-ray beam on various elements. The mesons are recognized and distinguished from protons by the variation of ionization with range and by multiple scattering on plates placed in the cloud chamber.

On the Measurement of Nuclear Moments of Excited States of Nuclei. ROLF M. STEFFEN, Purdue University.—One of the most valuable tools of nuclear spectroscopy for the determination of angular momenta and parities of excited states is the study of the angular correlation and the polarization direction correlation of successive nuclear radiations emitted from these states. In some cases the angular correlation is altered by electric and magnetic fields acting on the electric and magnetic moments of the nucleus. These fields may be externally applied fields or may be due to atomic, molecular, or crystal structure. A measurement of the magnetic moment and the electric quadrupole moment of excited nuclear

states then becomes possible. Moreover, the dependence of the angular correlation on the chemical and physical state of the radioactive source can provide information about the electric and magnetic fields prevailing at the decaying nucleus, and thus could give information on atomic and molecular structure and the structure of liquids and solids just as do nuclear magnetic resonance absorption and nuclear induction.

On a New Theory of Gravitation and Its Quantization. Frederik J. Belinfante, Purdue University.—Einstein's theory of gravitation in many regards is the most elegant theory of gravitation in existence. Its only disadvantage is the complicated form of its equations, which are not "linear" in the gravitational field, so that according to Einstein the "superposition principle" would not be valid for gravitational fields from different sources. This nonlinearity also makes its quantization much harder.

We have therefore formulated a somewhat simpler theory of gravitation, which is linear, and which it is easier to quantize. This new theory can explain the same experimental facts that Einstein's theory can explain. As far as perhaps the bending of light along the sun according to the experimental data does not exactly fit Einstein's theoretical value, the present theory can fit these data even better.

As for the red shift in the solar and stellar spectra, there is no possibility of comparing theory and experiment, as there are red shifts of a different origin related in some way with the temperature of the star, which cover up the effect pretty completely, and which are not understood theoretically at all. There may be reason to believe that the gravitational contribution to this red shift is much smaller than predicted by Einstein. Unfortunately, a first crude calculation of this effect according to the new theory leads to exactly the same prediction as made by Einstein, so that our theory is no improvement in this regard.

In general it should be said that the theory proposed by us is inferior to Einstein's theory from a philosophical point of view. Einstein starts from the general principle of relativity, and can directly derive his gravitational theory. Only one constant of interaction between matter and gravitation appears. We assume no general but only special relativity. Therefore, we had a much wider choice of theories. Our theory contains at the outset a large number of unknown constants. These are adjusted to explain the experimental data. Such a procedure is much more arbitrary than the one followed by Einstein.

Attempts at quantization of Einstein's theory itself therefore remain of interest, as long as it has not been definitely established that Einstein's theory would contradict the experimental facts. New attempts at such quantization by Gupta have had some success, and further development of this theory is desirable.