PROGRAM OF THE SECTION ON PHYSICS

Chairman: Leslie I. Steinbach, Central Normal College

1. Quadruple rotation—vibration spectrum of hydrogen. Hubert M. James, Purdue University.
2. Minimum stopping distances for automobiles. R. E. Martin, Hanover College.
3. The crystal detector as a rectifier of short waves. Mildred Williams Bulliet, Rockford, Illinois.
4. The angular distribution for resonance disintegration. R. D. Myers, Purdue University.
5. The basic principles of the physics of the universe. Arthur Haas, University of Notre Dame.
6. Comparison of the structure of natural and synthetic rubber. Eugene Guth, University of Notre Dame.
7. Collision of two Dirac particles. J. Franklin Carlson, Purdue University.
8. The structure of the non-crystalline forms of selenium. E. P. Miller and K. Lark-Horovitz, Purdue University.
9. Anomalous dispersion of calcite in the x-ray region. Robert M. Whitmer, Purdue University.
10. Can ferro-magnetism be detected by x-rays? K. Lark-Horovitz, Purdue University.
11. Effect of fringing flux in large magnets. J. D. Howe and I. Walerstein, Purdue University.
12. The production of radioactive substances by bombardment with alpha particles. W. J. Henderson, Purdue University.
13. Asymmetric radiation produced by cathode rays. Victor G. Reiling and George B. Collins, University of Notre Dame.
14. Likenesses and differences of resonance curves produced by damped wave and continuous wave transmitters. R. R. Ramsey, Indiana University.
15. Modulation. Herbert C. Hazel, Indiana University.
16. Stochastic processes and generating functions. E. S. Akeley, Purdue University.
17. The earth's forces and motions. A. F. Foley, Indiana University.
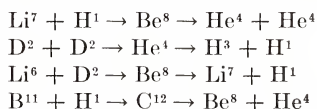
Seth Elliott, Butler University, was elected chairman of the Section for 1938.

ABSTRACTS

Quadrupole rotation-vibration spectrum of hydrogen. Hubert M. James, Purdue University.—Herzberg has suggested that it may be possible to prove the existence of hydrogen in planetary atmospheres

by observation in absorption of its quadrupole rotation-vibration spectrum. To make possible a quantitative discussion of this problem the theory of quadrupole transitions between Σ states of homonuclear diatomic molecules has been worked out and applied to this system. The quadrupole moment has been computed as a function of nuclear separation by the use of electronic wave functions obtained by a variational process. Matrix elements of this quantity have been computed using Morse and Pöschl-Teller vibrational functions. It is found that the intensity of the first line of the S branch of the fundamental band of hydrogen is $7.7 \times 10\text{-}9$ of that of the first line of the R branch in the fundamental band of hydrochloric acid. The first and second overtone bands have respectively .86 and .18 of the intensity of the fundamental band. It appears that this relative intensity, very much greater than that observed with dipole bands, is of the order to be expected in quadruple overtone bands in general.

The angular distribution for resonance disintegration. R. D. MYERS, Purdue University.—Using the Bohr scheme for the disintegration process, i.e., the formation and decomposition of a compound nucleus, the angular distribution is calculated when only one state of the compound nucleus is important. It is found that, in the co-ordinate system moving with the center of gravity, the produced particles are axial symmetric about the incident beam and are symmetric with respect to the plane normal to this axis. Further the highest harmonic found in the distribution cannot be greater than twice the l of the incident wave or the J of the compound state. (This rule was guessed but not proved by Teller.) The results are applied to the several experimental results of Neuert for the disintegrations:

$$\text{Li}^7 + \text{H}^1 \rightarrow \text{Be}^8 \rightarrow \text{He}^4 + \text{He}^4$$
$$\text{D}^2 + \text{D}^2 \rightarrow \text{He}^4 \rightarrow \text{H}^3 + \text{H}^1$$
$$\text{Li}^6 + \text{D}^2 \rightarrow \text{Be}^8 \rightarrow \text{Li}^7 + \text{H}^1$$
$$\text{B}^{11} + \text{H}^1 \rightarrow \text{C}^{12} \rightarrow \text{Be}^8 + \text{He}^4$$

The basic principles of the physics of the universe. ARTHUR HAAS, University of Notre Dame.—Physics of the universe may be based upon the following assumptions: (1) The radius of the universe is at the same time its gravitational radius (or $fM/c^2 = R$, where f is Newton's gravitational constant, M the mass of the universe, R its radius, and c the velocity of light); (2) For the largest distance possible in a closed universe (that is for πR) Hubble's recessional velocity becomes equal to the velocity of light; (3) The ratio A of the electrostatic force between a proton and an electron to the gravitational force between them is identical with the ratio of R to a, the classical radius of the electron $(a = e^2/(mc^2))$.

The use of these three principles leads to the relation that the total number of protons and neutrons in the universe is equal to A^2, that is equal to $(R/a)^2$. For the relation between the gravitational constant and Hubble's factor u (u ∞ 500 km./sec. per mega-parsec.), there follows the equation:

$$f = (\pi e^2 u a) / (m_p m c)$$

where m_p is the mass of the proton. On inserting the well-known values into the right-hand side of this formula we obtain for f, in perfect agreement with observational data, a value of 7×10^{-8}.

Comparison of the structure of natural and synthetic rubber. Eugene Guth, University of Notre Dame.—Rubber is built up from chain molecules, so-called macromolecules. All such substances, whether occuring naturally or prepared artifically, are invariably mixtures of molecules of different dimensions. This holds as long as they have not been fractionated into more or less homogeneous fractions. Under these circumstances, only a mean molecular weight of such macromolecular substances has a real meaning.

For long chain molecules the molecular weight is equivalent to a certain length of the chain of a certain number of chain links. The mean molecular weight is therefore equivalent to a certain mean length of the chain. It is now important that the different methods for the determination of this mean chain length generally lead to different results. In other words, the averaging process which gives us a mean chain length is not completely determined but depends on the kind of measurement used.

It is well-known both in pure science and in industry that one can get at least an estimation of this mean chain length by means of viscosimetric measurements. The greater the viscosity, the larger is the chain length. Analogous remarks hold concerning the determination of another mean chain length from osmometric measurements.

On the other hand, the tensile strength of a long chain compound also gives an estimate of a mean chain length. The larger the tensile strength, the larger is the chain length. But the chain length is not the only factor which determines the tensile strength. This depends also on the distribution function for the chain lengths. Of two substances with equal maximal chain lengths, that with a steeper distribution function will have the greater tensile strength. Steeper distribution function means greater chemical regularity of the structure.

Comparative measurements of the viscosity of crepe rubber and synthetic rubber on the one hand, and of the tensile strength of these substances on the other hand, lead to a surprising result. While the viscosity of a solution of rubber in benzine was two times as great as an equally concentrated solution of crepe rubber in the same solvent, the tensile strengths of both substances were approximately the same.

The explanation is that synthetic rubber has many longer chains than crepe rubber, but the influence of these chains on the tensile strength is over-balanced by the presence of a still greater number of much shorter chains, which the crepe rubber has on the average. This fact is also important for the elasticity of synthetic rubbers.

Collision of two Dirac particles. J. Franklin Carlson, Purdue University.—The collision cross section for two particles of arbitrary mass, charge and relative velocity is calculated on the assumption that the behavior of both particles may be described by Dirac wave functions. The effects of the retardation of the forces and the magnetic interactions are taken into account following a method due to Moller.

The expression for the differential cross-section obtained contains three types of terms. The first type is of the ordinary classical form. The other two types give the deviations due to retardation and the magnetic forces. In the interesting case of the collision of a high energy proton with an electron at rest these added terms become important only if the incident proton has an energy of the order of 10^{12} electron volts and if the energy transferred is comparable with the incident energy of the proton.

The structure of the non-crystalline forms of selenium. E. P. MILLER and K. LARK-HOROVITZ, Purdue University.—Using monochromatic x-rays the x-ray diffraction patterns of amorphous, liquid, and glasseous selenium have been studied. They are found to be identical within the limits of experimental error. The patterns have been analyzed by Fourier analysis, and it has been shown that each atom has only two nearest neighbors: thus only chains and rings can constitute the elementary domains in these forms. Experiments on the elastic properties of amorphous selenium by K. H. Meyer lead to the conclusion that chains must be the constituents. The results are discussed in connection with recent investigations on the question: is glass a super cooled liquid or a crystal?

Anomalous Dispersion of calcite in the x-ray region. ROBERT M. WHITMER, Purdue University.—The index of refraction of calcite for x-rays in the vicinity of Ca k-absorption edge has been determined, using a crystal having a face ground and polished so that a part of the emergent beam has a very small emergence angle and so is refracted appreciably. A new feature consists of splitting a single emergent beam striking one face of crystal into two emergent components. The theoretical works of Kallmann and Mark, Suguira, and Honl are reviewed and the results of the experiment compared with those of Honl.

Can ferro-magnetism be detected by x-rays? K. LARK-HOROVITZ, Purdue University.—Recalling that all magnetic properties of materials can only be understood as quantum phenomena and that ferro-magnetism in particular has to be considered as a spin exchange phenomenon in solids, the different possibilities for x-ray applications are discussed. It follows at once that no change in structure is to be expected and none has been observed. Considering intensities, the transition probabilities and oscillator strength for atomic levels and crystal levels have to be discussed. It can be shown that no effect can be observed in the K-region of x-rays, and the possibility to observe effects in the L-region is excluded by intensity considerations.

Effect of fringing flux in large magnets. J. D. HOWE and I. WALERSTEIN, Purdue University.—In the design of the magnet for the Purdue cyclotron the pole pieces were shaped in such a way as to obtain as high a value for the velocity of the accelerated particles as possible. This design, in common with all other types of design, results in a considerable amount of magnetic flux fringing in the space outside the pole gap. The Ampere interaction of this fringing flux with the current in the energizing coils produces a force which may even be larger than

the weight of the coils. Furthermore this force is one causing a repulsion of the coils away from the neighborhood of the gap, and if the axis of the coils is vertical, the upper coil has a tendency to "float." Complete mapping of the magnetic field in the neighborhood of the pole pieces showed that for an energizing current of 160 amps the field in the air gap between the pole pieces is 15,200 gauss, and the horizontal component of the field in the neighborhood of the coils has an average value of 750 gauss. The resulting force on the upper coil amounts to a lift of 3.4 tons.

The production of radioactive substances by bombardment with alpha particles. W. J. HENDERSON, Purdue University.—The elements B, N, Mg., Al, P, Cl, Cr, NiCo, Cu, As, and Br have been bombarded with 9 M. E. V. alpha-particles accelerated in a cyclotron. The half lives and thick target yields of the resulting radioactive bodies have been measured. In a few cases the energy of the β-rays emitted has been estimated by the absorption method. Where the radioactive isotopes were not previously known, they have been identified by chemical tests, on the sign of the charge on the electrons emitted, and by correlation with results with other bombarding particles. The experiments were done at Princeton University in collaboration with L. N. Ridenour.

Asymmetric radiation produced by cathode rays. VICTOR G. REILING and GEORGE B. COLLINS, University of Notre Dame.—The asymmetric emission of light produced in a liquid by electrons of high velocity, which was first reported by Cerenkov, has been verified. 1400 k.v. electrons (3 μa.) were used to produce the light emission. The effect was also found to occur in solids such as glass and mica. Water, methyl alcohol, benzene, and carbon tetrachloride all were found to produce the asymmetric radiation. It was also verified that the direction of emission with respects to the direction of the cathode rays depends upon the refractive index of the medium in which the light is produced.

Modulation. HERBERT C. HAZEL, Indiana University.—In order that one periodic disturbance may modulate another, a product of the two must be produced in some way. Sounds from separate loud speakers actuated by audio oscillators give no product terms in air. Analysis by an acoustical wave-meter showed no combinational tones present, though the beat notes were uncomfortably loud in the ear. Connecting two speakers together with wire likewise failed to produce modulation. However, impressing one frequency upon the field coil and another upon the voice coil of a dynamic speaker gave distinct modulation products. There has been, and still is, great confusion among physicists concerning the conditions for modulation and the objective reality of frequencies produced by modulation. Frequencies derived from modulation, which must involve a multiplication of parent disturbances, elicit peak response in devices tuned to them.

Stochastic processes and generating functions. E. S. AKELEY, Purdue University.—We shall consider the motion of a system of n particles where the probability that the system is in a given state is a function of its state at a previous instant of time. Generating functions are

given for computing the probability of transition from one state to another in terms of the transition probabilities for the particles themselves, both in the case of the classical and the Bose-Einstein statistics. Methods are given for computing mean values of functions of the state of the system.

The earth's forces and motions.   A. L. FOLEY, Indiana University.— The author will show that some of the statements of text books about gravity, the center of the earth, and the earth's motions are not strictly true.   Some are very far from being true.