PHYSICS

Chairman: DUANE ROLLER, Wabash College

C. Hire, Indiana University, was elected chairman for 1951.

ABSTRACTS

Beta spectrum of Rb^{86}*. E. BLEULER and R. M. STEFFEN, Purdue University.—Rb^{86} is reported to decay by emission of two β-ray groups.[1] Since an anisotropic β-γ-correlation has been found[2] the shape of the partial β-spectrum which is followed by the γ-ray should deviate from that for an allowed transition. Coincidences were measured between the β-particles focussed in a double-coil lens type spectrometer and the γ-rays detected with a scintillation counter. A source of 0.08 mg/cm^2 was used, prepared from a sample of Rb^{86} obtained from the Isotopes Division of the U. S. Atomic Energy Commission. The conventional Fermiplot shows no distinct deviation from a straight line above 0.27 Mev. The application of different correction factors will be discussed. The Fermi-plot of the total β-spectrum shows a definite curvature which is slightly overcompensated by the application of the correction factors for first and second forbidden transitions.

Isomerism of In^{110}*. J. W. BLUE and A. C. JOHNSON, Purdue University.—The (α, 2n)-reaction on silver leads to an activity of about 5 hours half-life assigned to In^{109}. A similar period is found for the product of an (α, 3n)-reaction[3] and has been assigned to In^{108} (from Ag^{107}), since In^{110} (from Ag^{109}) was known to decay with a half-life of 65 min. On the other hand, a period of 55 min. has been found for In^{108} produced by a (d, 2n)-reaction on Cd^{108} [4]. The discrepancy has been removed by showing that In^{110} has an isomer of 4.8$\pm$0.3 hours half-life. It was found by following the decay of the conversion electrons emitted from the well known level at 656 kev of Cd^{110}. A conversion line corresponding to a γ-ray of 119 kev follows approximately the same period and may be due to the isomeric transition.

Nuclear energy levels from proton groups in (α, p) reactions. M. LOREN BULLOCK, WILLIAM O. MCMINN, and MILO B. SAMPSON, Indiana University.—Thin targets of Be^9 and C^{12} have been bombarded with 23 Mev α-particles from the Indiana University cyclotron. The number

* Supported by the ONR

[1] D. J. Zaffarano, B. D. Kern and A. C. G. Mitchell, Phys. Rev. **74**, 682 (1948)

[2] D T. Stevenson and M. Deutsch, Bull. A.P.S. **25**, No. 2, 9 (1950)

[3] S. N. Ghoshal, Phys. Rev. **73**, 417 (1948)

[4] E. C. Mallary and M. L. Pool, Phys. Rev. **76**, 1454 (1949)

of protons given off at 90° relative to the cyclotron beam has been measured for various proton energies. This was done by placing various aluminum absorber foils in front of a proportional counter biased so as to count only those particles that stop in the counter. From the proton groups thus found we have calculated the ground states and excited states of the product nuclei, B^{11} and N^{14}, respectively.

Radiations from Mo^{99} and Tc^{99m}. ROBERT CANADA and ALLAN C. G. MITCHELL, Indiana University.—The radiations from Mo^{99} (67 hrs.) and its metastable daughter Tc^{99m} (6 hrs.) have been measured in a magnetic lens spectrograph. The beta-ray spectrum consists of a group with an end-point energy of 1.23 Mev, one of 0.445 Mev, and possibly a third lower energy group. The relative intensities of the 1,23-Mev to 0.445-Mev groups are 4:1. Gamma rays have been found at 0.040, 0.140, and 0.181, 0.367, 0.741 and 0.780 Mev. The gamma rays at 0.040, 0.140 and 0.181 Mev are internally converted. The spectrum of Tc^{99} consists of one internally converted gamma ray at 0.140 Mev. A disintegration scheme is proposed.

The optical properties of semiconducting materials. H. Y. FAN and M. BECKER, Purdue University.—Silicon and germanium are found to have high transparency for infrared radiation beyond a sharp absorption edge. The absorption coefficient is determined by measurements of transmission through bulk samples. It increases towards long wave-lengths and is larger for samples of lower resistivity. The absorption, though small, is higher than predicted by either the usual or a more elaborate theory of absorption by free carriers. On the other hand measurements on neutron irradiated silicon show that free carriers do play an important role in the absorption. Measurements at low temperatures show that in certain cases localized energy states are important for the absorption. The position of the sharp absorption edge checks approximately with the known width of the energy gap and shifts with temperature. Theoretically calculated temperature dependance of the energy gap, which agrees with estimates based on electrical measurements, is in good agreement with the observed shift in silicon, but is too small to explain the shift in germanium. Reflectivity measurements by Lark-Horovitz and Meissner are also reported. Both materials have constant reflectivity over wide regions in the infrared, from which the index of refraction is calculated to be 3.5 and 4.0 for silicon and germanium respectively. With high transparency and constant large index of refraction these materials may find useful applications in infrared work, and the sharp rise of the absorption edge makes them good filters.

New approximation method for treatment of order-disorder transitions. HUBERT M. JAMES and LLOYD D. FOSDICK, Purdue University.—The order-disorder problem of the square Ising array in two dimensions has been discussed by an extension of Bethe's method. A 3x3 section of this array is considered, and account is taken of (a) the tendency of interaction with external atoms to induce short-range order, as well

as long-range order, in the outer sites of this section, and (b) the differing control of long-range order exerted by this interaction for non-equivalent sites in the outer shell. The theory thus involves three parameters instead of the one parameter of Bethe's theory. This more careful treatment of short-range order greatly improves the accuracy of the method, which in an elementary manner yields results comparable to those of Kramers and Wannier, and much superior to those of other approximation methods. The predicted Curie point is some 7% higher than the exact value. The short-range order is in good agreement with the exact results of Onsager for all temperatures, with maximum error around the Curie point. The theory predicts a specific heat varying like $(T\text{-}T_c)^{-\frac{1}{2}}$ as T approaches the Curie temperature T_c from below, whereas other approximation methods predict finite values; Onsager's exact result varies as — log $(T\text{-}T_c)$.

Fermi levels in semiconductors. GUY W. LEHMAN, Purdue University.—In nucleon irradiated semiconductors additional donator and acceptor states appear.[1] The Fermi level changes as a function of the total number N of defects introduced. When more donator levels than acceptor levels are introduced, P-type material changes to N-type during bombardment. For equal numbers of donators and acceptors (lattice vacancies and interstitials) produced, with activation energies of 0.15 ev. and 0.05 ev. respectively, the Fermi level in all cases approaches the limiting value 0.275 ev. above the middle of the forbidden gap as N increases: initially N-type material is converted to P-type material and initially P-type material shows decreasing resistance if the initial concentration of impurities is moderate as observed in Ge. A model corresponding to bombardment-induced transmutations[2] producing three acceptor impurities for each donator shows that N-type material is converted into P-type and P-type material shows decreasing resistance, again as observed in Ge after heat treatment to remove lattice imperfections.

1. LARK-HOROVITZ, K. et al, Deuteron Bombarded Semiconductors, Phys. Rev. 73, 1256(A), 1948.

2. CLELAND, J. W., LARK-HOROVITZ, K., and PIGG, J. C., Transmutation-produced Germanium Semiconductors, Phys. Rev. 78, 814(L), 1950.

Observations on the Michelson Interferometer. RALPH A. LORING, University of Louisville.—If the dividing mirror of the Michelson Interferometer is not silvered two sets of fringes will be formed. These may be formed in different planes and so they may be separated if a telescope is used for observation. However, there are some circumstances under which both sets are desirable. Both sets may be observed simultaneously without confusion if a grid is placed at the collimating lens. Then one half of the field will contain one set of fringes and the other half will contain the other set.

Angular correlation of the gamma-rays emitted from the excited states of A^{38}*. R. M. STEFFEN, Purdue University.—The angular corre-

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lation of the two γ-rays emitted in cascade from A^{38} after the β-decay of Cl^{38} has been measured using two anthracene scintillation counters and a coincidence circuit with a resolving time of 5.8×10^{-8} sec. The apparatus was checked by a careful measurement of the known correlations obtained from Ni^{60} and Pd^{106}. In the case of A^{38} the probability that the two γ-rays are emitted at an angle ζ is proporational to $f(\zeta) = 1 - (1/3)\cos^4\zeta$. This correlation is characteristic for two quadrupole quanta and angular momenta 3, 2, 0 for the states involved. While the values of the spins are in agreement with the results obtained by the study of the β-decay of Cl^{38} a serious dfficulty arises in the assignment of parities. The relative intensities of the partial β-spectra suggest the same parity for the ground state and the first excited state, the opposite parity for the higher excited level. On the other hand, the quadrupole character if the two γ-rays and the small probability of the cross-over transition require the same parity for all three states.

A method of determining the dielectric constant of moist air at a frequency of 9500 megacycles. CLAYTON M. ZIEMAN, Wabash College.— The resonance frequency of a cavity changes when the medium filling the cavity is changed. If a cavity is first evacuated, then filled with moist air and the change in resonance frequency observed, the dielectric constant of the moist air can be calculated. Actually two cavities are used, one serving as a reference cavity. The shift in the resonance frequency is observed by having the resonance pulses, on the same time base, appear simultaneously on an oscillograph screen. This is done by electronic switching.

High energy radiations from V^{48}*. W. ZOBEL, Purdue University.— V^{48} decays by positron emission to a level of Ti^{48} of 2.31 Mev excitation energy, from which two γ-rays are emitted in cascade. Supplementary to a proposed investigation of the angular correlation of these γ-rays, a search was made for high energy positrons and a cross-over γ-ray employing the cloud chamber method of Morganstern and Wolf.[1] The V^{48} was produced by bombarding Ti^{48} with deuterons and separated chemically. A small number of high energy positrons is emitted, probably in a direct transition to the ground state of Ti^{48} with an intensity of $4 \times 10^{-4}\%$. The cross-over γ-ray was found in 4.6% of the decays. Tentative assignments of spin and parity to the different states will be given.

* Supported by the ONR

[1] K. H. Morganstern and K. P. W. Wolf, Phys. Rev. **76**, 1261 (1949)