Symposium on Low Temperature Physics

(J. M. REYNOLDS presiding)

Invited Papers

A1. Liquid and Solid He^3. WILLIAM M. FAIRBANK, *Duke University.* (30 min.)

A2. Some Experiments on the Tensile Strength of Liquid Helium. J. W. BEAMS, *University of Virginia.* (30 min.)

A3. Studies in Solid State Physics at Low Temperatures. C. F. SQUIRE, *Rice Institute.* (30 min.)

A4. Effects of Elastic Deformations on Superconductivity. CLAUDE GRENIER, *Louisiana State University.* (30 min.)

A5. Superconductivity at Microwave Frequencies. WALTER GORDY, *Duke University.* (30 min.)

Biophysics

(JOHN S. KIRBY-SMITH presiding)

B1. Study of the Effects of Varying Concentrations of Na and K on Trace Element Determinations in a Biological Tissue Ash. CHARLES A. BOYE, JR., *Tennessee Eastman Company,* AND ISABEL H. TIPTON, *The University of Tennessee and Oak Ridge National Laboratory.*—In the program of analysis of human tissue by emission spectrography, one set of standards has been used for the analysis of all types of soft tissues. Since these tissues vary somewhat in concentration of major constituents, sodium and potassium, it was felt that a study should be made on the effects of varying concentrations of sodium and potassium on the determination of trace elements. Matrices containing concentrations of potassium in the ratio K/Na of 0.344, 0.680, 1.24, 2.36, 5.72 were mixed and the effects of these variations on the elements Cd, Cu, Mn, Mo, Pb, Sn, and Zn were measured. No significant effect on the determination of these elements was observed.

B2. Relative Effects of Gamma Rays, Fast Neutrons, and α Particles on Free Radical Production. J. S. KIRBY-SMITH AND M. L. RANDOLPH, *Oak Ridge National Laboratory.*—A study of the relative efficiency of the free radical production by various ionizing radiations on simple biochemical systems has been carried out. Free radicals produced by the action of 1.17- and 1.3-Mev cobalt-60 gamma rays, 1.4-Mev fast neutrons from the D-T reaction, and 5.3-Mev α particles from polonium have been studied by paramagnetic resonance techniques. These radiations of widely different linear energy transfer (LET) give the same resonance patterns in irradiated amino acids, but show the expected large variation in number of uncoupled electron spins produced per unit energy absorbed. For glycine, the relative efficiency of gamma rays, fast neutrons, and α particles is in the ratio 1:0.7:0.1. These measurements show clearly the wastage of ionization in the case of free radicals induced by the particulate radiations of high LET values. The possible interpretation of the relative biological effectiveness (RBE) of various ionizing radiation of different LET will be discussed briefly in terms of these results.

B3. Interactions of 14.1-Mev Neutrons with Biological Tissue. M. L. RANDOLPH, *Oak Ridge National Laboratory.*—A description, adequate for quantitative radiobiology, of the first collision interactions and energy dissipation resulting from the irradiation of biological tissue with 14.1-Mev neutrons, copiously available from the $H^3(d,n)He^4$ reaction, should indicate per unit flux the total dose rate, the dose rate due to each ionizing product formed, and the distribution or at least a well-defined average of the linear energy transfer (LET) of all the ionizing products. The calculation of these quantities requires prior knowledge of all the reactive nuclear cross sections for 14-Mev neutron interactions with H, C, N, and O, the differential cross sections for neutrons scattered by these elements, quantitative values for the rate of energy loss of nuclei at energies less than that at the Bragg peak, and elementary composition of the irradiated medium. Calculations have been made, with allowance for these considerations, of the dose rate to flux ratio, track average LET, defined as $\int L\xi(L)dL/\int\xi(L)dL$, and energy average LET, defined as $\int L\Theta(L)dL/\int\Theta(L)dL$, where $\xi(L)dL$ and $\Theta(L)dL$ are the fractions of total track length and total energy of particles as they pass through the LET range dL. The importance of each complicating consideration mentioned previously will be discussed.

B4. Magnetically Suspended Equilibrium Ultracentrifuge.* J. W. BEAMS, W. C. SIMPSON, AND K. D. WILLIAMS, *University of Virginia.*—Some improvements in the magnetically suspended equilibrium ultracentrifuge[1] are described. Due to the excellent thermal insulation and extremely low friction of the magnetically suspended "coasting" highly polished ultracentrifuge rotor, the rotor temperature fluctuates less than the metal walls of the vacuum chamber which surround it. The temperature of the chamber is measured and held constant to about one part in 10^4. The speed of the "coasting" rotor is free from hunting and can be determined to one part in 10^6. The Jamin-type interferometer previously described for measuring sedimentation has been markedly improved by making use of three light beams instead of two. One beam passes through the solution and the other two through the solvent. Three separated fringe patterns each superimposed on an image of the centrifuge cell are produced. This provides reference fringe sets from which fringe movement due to sedimentation can be determined with greater reliability. A shift of about 0.003 fringe can be observed. A modified Twyman type interferometer also is being developed.

* Supported by National Science Foundation.
[1] Beams, Dixon, Robeson, and Snidow, J. Phys. Chem. **59**, 915 (1955).

Invited Paper

B5. Realities in Biophysics. CHARLES W. SHEPPARD, *Oak Ridge National Laboratory.* (30 min.)

Experimental Techniques and Apparatus

(B. D. KERN presiding)

C1. Compact, Pressurized 2-Mev Electrostatic Accelerator. T. M. HAHN, JR., A. ROBESON, AND J. L. RYAN, *Virginia Polytechnic Institute.*—A small pressurized accelerator with a design limit of 100 microamperes at 2 Mev has been completed and will be described. This installation utilizes a horizontal accelerator column in a readily available, removable pressure tank 4 feet in diameter and 10 feet long. Operating pressure is 150 psig. Support members are Textolite tubes, with an insulating length of 3 feet. A Moak type radio-frequency ion source is used. Power for the source and associated circuits is supplied by a 500-watt permanent magnet alternator. Voltage stabilization is effected through a 90 degree magnetic analyzer and corona feedback system. Provision has been made for conversion to 4 Mev with a vertical accelerator column in a new building.

C2. Versatile, Natural-Uranium Subcritical Assembly.* T. M. SCHULER, JR., A. ROBESON, AND T. M. HAHN, JR., *Virginia Polytechnic Institute.*—An exponential assembly utilizing 30 000 pounds of AGOT grade reactor graphite and 2500 pounds of natural uranium has been constructed and will be described. A 15-curie polonium-beryllium source is used as a neutron source. Design considerations, constructional details, and performance data will be given. Results of measurements of the diffusion length, Fermi age, and material buckling will be presented. Experience with the use of this installation in reactor training programs will be given. Plans are underway for the use of a pulsed neutron source with this assembly.

* Supported in part by the U. S. Atomic Energy Commission.

C3. Preparation of Thin, Uniform Sources for a Beta-Ray Spectrometer. R. L. BLANCHARD,* B. KAHN,* AND R. D. BIRKHOFF, *Oak Ridge National Laboratory.*—The nonuniform activity distribution found in sources prepared by evaporation of a radioactive solution indicated a need for other methods. Radiocolloidal sorption and electrodeposition of ruthenium-106, silver-110, mercury-203, cobalt-60, indium-114, chromium-51, iron-57, gold-198, iridium-192, and selenium-75 produced uniform deposits as indicated by radioautographs. Sources were prepared on a 25 $\mu g/cm^2$ Formvar-polystyrene film made conducting by the vacuum evaporation of 30 $\mu g/cm^2$ of gold onto the surface. A gold-199 source was obtained by irradiating platinum metal in the ORNL-LITR, and then allowing the decay of platinum-199 to gold-199. The gold-199 was extracted from 6 *M* HCL into ethyl acetate, evaporated to dryness, redissolved in 0.5 *M* aqua regia, and deposited onto the gold film at 4 volts and 50 ma/cm^2. The K and L lines of the 159-kev and 209-kev gamma rays were examined in a solenoidal magnetic spectrometer. The peaks were symmetrical at a momentum resolution of 0.2% thus giving evidence for uniformity of deposition and low solid content of the source.

* U. S. Public Health Service, assigned to the Health Physics Division at ORNL.

C4. Preliminary Study of Post-Acceleration in a Beta-Ray Spectrometer. W. T. ACHOR,* A. W. SMITH,† AND S. K. HAYNES, *Vanderbilt University.*—Reduction of counter window thickness to ~3 $\mu g/cm^2$ permits the measurement of relative intensities of electrons down to ~2.5 kev with a beta-ray spectrometer.[1] One method of extending the usable range to zero kinetic energy is post-acceleration. A disadvantage of this method, as shown previously,[2] is the production of spurious counting as a function of accelerator voltage. This study indicates that below 5 kv, while there is some increase in counting rate with no source present, none of the spurious counting is due to electrical discharges, and most is due to low-energy electrons multiply-scattered from the source (Cs^{137}). Use of the ionization gauge tube as a source of low-energy electrons confirms the latter conclusion. Factors tested which have no effect on the operation of the accelerator below 5 kv are temperatures (10–25°C) and spectrometer pressure (2×10^{-5}–2×10^{-4} mm Hg). Use of a grid instead of an open hole as ground electrode gave some evidence of more stable operation. It is believed that more effective shielding of the counter from the source would allow satisfactory use of this method.

* Now at Western Reserve University.
† Deceased.
[1] Burford, Lafferty, Thomas, and Haynes, Bull. Am. Phys. Soc. Ser. II, **1**, 260 (1956).
[2] K. Siegbahn (Editor), *Beta- and Gamma-Ray Spectroscopy* (Interscience Publishers, Inc., New York, 1955), p. 272.

C5. Fluorescent Response of CsI(Tl) to Nitrogen Ions. M. L. HALBERT, *Oak Ridge National Laboratory.*—The relative light output L of a CsI(~0.1% Tl) crystal has been measured using nitrogen ions, α particles, and γ rays. The nitrogen ions, from the ORNL 63-inch cyclotron, were scattered through 90° by a gold target into the crystal. Energies less than the maximum cyclotron energy (27.9 Mev) were obtained by inserting nickel foils in the unscattered beam. The energy loss was calculated from the empirical range-energy relation.[1] Nitrogen ions give linear response up to $E\sim16$ Mev. At higher energies, L *vs* E is slightly concave. The pulse height at 16.5 Mev equals that for a 5.30-Mev α particle. The energy response for α particles was measured using a Po^{210} source and aluminum foils, the energy loss being obtained from experimental data.[2] The response is linear above ~3.5 Mev and extrapolates to ~1 Mev. For γ rays of 279.2 and 411.8 kev, L *vs* E is fit well by a straight line passing through the origin and parallel to the linear portion of the α response curve.

[1] Reynolds, Scott, and Zucker, Phys. Rev. **95**, 671 (1954).
[2] S. Rosenblum, Ann. phys. **10**, 408 (1928).

C6. The Response of the Anthracene Scintillation Counter to Monoenergetic Electrons. L. W. JOHNSTON, R. D. BIRKHOFF, J. S. CHEKA, H. H. HUBBELL, AND B. G. SAUNDERS, *Oak Ridge National Laboratory.*—An electron accelerator supplied monoenergetic electrons of energies between 10 and 120 kev. The beam was incident upon thin bare anthracene crystals centered on the photocathode of an RCA 6199 photomultiplier. The reflector consisted of a hollow truncated cone placed with the base concentric to the photocathode. An *A*-1 linear amplifier and single channel analyzer were used to obtain a pulse-height distribution at each energy. The peak pulse height is a linear function of the incident electron energy with intercepts of 4.5 kev and 3.5 kev for the 0.060-inch and 0.011-inch crystals, respectively. The pulse-height distribution could be fitted well with a Gaussian. The data indicate a linear relationship between the square of the width of the pule-height distribution at half-maximum and the electron energy. The average amount of electron energy absorbed in the crystal required to produce a photoelectron at the photocathode is 1.47±0.08 kev/photoelectron for the 0.060-inch crystal and 1.32±0.13 kev/photoelectron for the 0.011-inch crystal.

C7. Calutron Collections of Inert Gas Isotopes. H. B. GREENE, *Oak Ridge National Laboratory* (introduced by J. R. Sites).—In connection with the program of enriching stable

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