PHYSICS

Chairman: Richard L. Conklin, Hanover College

Ralph A. Llewellyn, Rose Polytechnic Institute, was elected Chairman for 1970

ABSTRACTS

Measurement of Ionization in Nuclear Emulsion by Lacunarity Technique. W. David Mueller, Ball State University.—Lacunarity was studied as a technique of measuring ionization and energy loss of a charged particle passing through nuclear emulsion. Lacunarity is a measure of track density and is defined as the linear fraction of a track segment that consists of gaps. Measurements were made of blob density and lacunarity of segments of tracks of particles emanating from nuclear disintegration in nuclear emulsion. Both blob density and grain density as determined by lacunarity were plotted versus residual range of track segments to compare the two methods of measuring ionization.

Except for tracks of very heavy ionization and tracks of light ionization, grain density as determined by lacunarity is a better measure of ionization than blob density. Both theoretical and experimental results indicate that over a considerable range of ionization, blob density does not vary greatly with the degree of ionization. Also, particles could be distinguished by lacunarity which could not be distinguished by blob density.

Operation and Flux Determination of a Neutron Generator. Martin A. Burkle and Leon M. Reynolds, Ball State University.—A neutron generator-accelerator consisting of a 150 kv Cockroft-Walton accelerator which makes use of the $^{3}H(d, n)^{4}He$ reaction was placed in operation by the Department of Physics, Ball State University. Experiences associated with the installation and startup of the equipment were described along with projected uses. Preliminary results for neutron flux determinations using 2.8 Mev neutrons produced by the $^{2}H(d, n)^{3}He$ reaction were given. The usefulness of the device for experimentation in the advanced undergraduate or beginning graduate laboratory was considered.

Molecular Structure of Thyroxine by X-Ray Crystallography. L. K. Steinrauf, O. Seely, J. A. Hamilton and J. M. H. Pinkerton, Indiana University Medical Center.—The molecular structure in the crystal form of the thyroid hormone thyroxine was determined by single crystal x-ray diffractometry using the Supper-Pace Autodiffractometer. The structure was found to consist of planar layers of the hormone separated by layers of water molecules, all connected by a highly complicated network of hydrogen bonds. A possible charge transfer bond exists between molecules of thyroxine. The hydrogen bonds and the charge

transfer bond provide the means for speculation on the manner in which thyroxine can bond to blood serum proteins.

Electron Paramagnetic Resonance Studies on The Magneli Phases of the Titanium-Oxygen System.[1] JOHN F. HOULIHAN and L. N. MULAY, Pennsylvania State University.—Several transition metal oxides exhibit a number of stable phases with variable stoichiometry, different from that predicted by simple valence considerations of the cation. These oxides have well-defined crystal structures and are known as Magneli phases.

Magnetic susceptibility studies by Mulay and others on the phases of the titanium-oxygen system described by Ti_nO_{2n-1} and recent electrical conductivity data by Bartholomew of the Materials Research Laboratory have revealed several interesting semi-conductor to metal transitions.

In this paper, typical exploratory electron paramagnetic resonance spectra studied as a function of temperature are presented for the following oxides: Ti_3O_5, Ti_4O_7, Ti_5O_{11}, and Ti_7O_{13}. The electron paramagnetic resonance data, in general, have confirmed the transitions previously observed by other means.

Proposed lines of interpretation correlating electron paramagnetic resonance parameters (such as g values, asymmetry of line shapes, etc.) with the magnetic data and the observed transitions were presented.

An Evaluation of Relativistic Thermodynamics. DARRYL L. STEINERT, Hanover College.—The problem of the accuracy of the formulations of relativistic thermodynamics proposed by Planck, Eckart, Ott, and Landsberg was examined. Due to the lack of experimental data on relativistic thermodynamic systems, it is not possible to compare predictions made by the various formulations with experimental data. But, using the process of evaporation as a model, I found that it is possible to study the consistency between the transformation laws for temperature and for mechanical energy. The result obtained was that only Ott's formulation is free of contradiction.

Ott's proposed transformation laws were further evaluated in terms of their compatibility with relativistic formulations of fluid dynamics and statistical mechanics. Compatibility is to be expected because thermodynamics, fluid dynamics, and statistical mechanics are compatible in their non-relativistic formulations.

The lack of contradiction between Ott's formulation and the transformation law for mechanical energy, and its compatibility with formulations of relativistic fluid dynamics and statistical mechanics, gave support to a conclusion that Ott's formulation of relativistic thermodynamics is correct.

[1] We acknowledge Prof. W. B. White for providing samples and Mr. W. J. Danley for assistance. This work was initially sponsored by AEC contract AT(30-1)-2581.

Physical Oceanography in Indiana: A Study of Horse Shoe Lake. RALPH A. LLEWELLYN, Rose Polytechnic Institute.—During the spring of 1969, a thorough experimental oceanographic study was conducted of a large artificial lake in west-central Indiana. Initiated as an educational exercise for a group of 67 science and engineering students, the study developed into an integrated recording and analysis of 7 parameters of the lake over a several week period.

The results of the study included a computer-drawn contour map of the bottom, the discovery of an unexpected region of "dead" water, evidence for a sub-surface current, and the formulation of plans to moor continuous recording gear in the lake. This concentrated study could well serve as a prototype for such investigations by other colleges.

NOTES

Polarized $^3He+$ Ion Source for the Indiana University Cyclotron. J. H. HETTMER, Indiana University.—An optically pumped polarized Helium-3 ion source, similar to that designed and constructed at Rice University (1), is being built for use with the cyclotron now under construction at Indiana University (2, 3, 4). This cyclotron will be particularly well-suited to this purpose due to its unique property of accepting low-energy positive ions at ground potential for acceleration to high energies. This is of interest because experimental data concerning the scattering of, and nuclear reactions induced by, these particles are extremely difficult to obtain by any other technique.

Previous work on this type of ion source, together with adaptations and improvements associated with this application was described.

Literature Cited

1. FINDLEY, D. O., S. D. BAKER, E. B. CARTER, and N. D. STOCKWELL. 1969. A Polarized $^3He+$ Ion Source. Nucl. Instr. and Method. **71**:125-132.

2. SAMPSON, M. B., M. E. RICKEY, B. M. BARDIN, and D. W. MILLER. 1967. Planned 200-MeV Indiana University Cyclotron: Properties and Unique Features. Proc. Indiana Acad. Sci. **77**:347-348.

3. RICKEY, M. E., M. B. SAMPSON, B. M. BARDIN, and D. W. MILLER. 1966. Proposed Indiana University 200-MeV Multi-Particle Variable Energy Cyclotron Facility. I.E.E.E. Trans. Nucl. Sci. **NS-13**:464-468.

4. RICKEY, M. E., M. B. SAMPSON, and B. M. BARDIN. 1969. General Design Features of the Indiana University 200-MeV Cyclotron. I.E.E.E. Trans. Nucl. Sci. **NS-16**:397-414.

Non-local Contributions to the Cyclotron Absorption Spectrum for a Single Valley Semiconductor Model. UWE J. HANSEN, Indiana State University, and JAMES L. HAZELTON, Oklahoma State University.—In a material like PbTe for which at 35 Ghz the skin depth is of the same order of magnitude as the radius of carrier orbits at cyclotron resonance, semiclassical calculations of the cyclotron absorption coefficient indicate that absorption maxima should be observed for dielectric anomaly, rather than the expected cyclotron resonance conditions (1). Experiments indicate, nevertheless, that some structure is observed at the cyclotron frequency (1). A non-local calculation, adapted from Hebel's calculations for Bismuth (2), for a single ellipsoidal Fermi Surface with PbTe parameters was carried out for the limited case of the magnetic field orientation along the major symmetry axis and the microwave electric field parallel to the magnetic field. This calculation indicated an absorption maximum at the cyclotron frequency (3). More extensive calculations are in progress.

Literature Cited

1. HANSEN, U. J., J. H. GARDNER, and K. F. CUFF. 1966. Analysis of cyclotron absorption in PbTe. Bull. Amer. Phys. Soc. 11(5):755.

2. HEBEL, L. C. 1965. Cyclotron resonance in Bi with slightly anomalous skin effect. Phys. Rev. 138(6A):1641-1649.

3. HAZELTON, J. L. 1969. Semiclassical calculation of cyclotron absorption in lead telluride. Unpublished M.S. Thesis, Indiana State Univ., Terre Haute.