Meetings and Societies

Theoretical Reactor Physics

A conference on theoretical reactor physics was held 23 to 25 Sept. 1957, in Sun Valley, Idaho. This conference, which also served as the fall meeting of the Reactor Physics Planning Group (an advisory body to the U.S. Atomic Energy Commission), was sponsored by the Atomic Energy Division of Phillips Petroleum Company and the Idaho Operations Office of the Atomic Energy Commission.

Twenty-six invited papers were presented at the conference; those presented on 23 September were devoted to nuclear physics, those on 24 September, to reactor statics, and those on 25 September, to reactor kinetics.

Almost 100 men were present for part or all of the meetings. There were representatives from the Atomic Energy Commission, Argonne National Laboratory, Atomics International, Atomic Power Development Associates, Inc., Brookhaven National Laboratory, California Institute of Technology, E. I. DuPont De Nemours and Company, General Atomics, General Electric Company, the Knolls Atomic Power Laboratory, Los Alamos Scientific Laboratory, the A.E.C. Computing Center at New York University, Oak Ridge National Laboratory, Phillips Petroleum Company, Ramo-Wooldridge Corporation, the Rand Corporation, the University of California Radiation Laboratory (Livermore), and the Westinghouse Atomic Power Division.

Sessions were held in Sun Valley's Holiday Hut each morning and evening; the afternoons were left free in order that the conferees might participate in Sun Valley's extensive sports program or explore the surrounding countryside.

The first session was opened by W. B. Lewis (Phillips Petroleum Company), who welcomed the members of the conference on behalf of the company and of the Idaho Operations Office of the Atomic Energy Commission. He then turned the meeting over to A. M. Weinberg (Oak Ridge National Laboratory), who introduced the topic for the day and presided over the two sessions.

The following papers were presented: "Nuclear reactions in stars and supernovae," W. A. Fowler (California Institute of Technology); "Present status of experimental neutron cross sections," D. J. Hughes (Brookhaven National Laboratory); "Wigner-Eisenbud multilevel formalism," C. W. Reich (Phillips); "Comparison of multilevel and single-level fits for U^{233}," R. G. Fluharty (Phillips); "Capture cross sections near 25 kev," R. L. Macklin, N. H. Lazar, and W. S. Lyno (Oak Ridge); "Recent developments in the calculation of resonance absorption probabilities," N. Corngold (Brookhaven); and "Some aspects of inelastic scattering," A. W. McReynolds and M. Nelkin (General Atomics), R. Carter (Westinghouse), and R. M. Brugger (Phillips).

The second day began with an introductory talk on reactor statics by B. I. Spinrad (Argonne National Laboratory) who presided over the morning and evening sessions. At these two sessions the following papers on reactor statics were presented: "Status of fast reactor theory," H. H. Hummell and W. Loewenstein (Argonne); "Convergence of S_n code and numerical integration of reactor kinetics equation," E. R. Cohen (Atomics International); "Theory of coupled reactors," R. Avery (Argonne); "Externally moderated reactors," G. Safonov (Rand); "Neutron thermalization," M. Nelkin (General Atomics); "Prompt excursions of a water cooled solid homogeneous reactor," N. Rostoker (General Atomics); "Resonance absorption in lumps: recent progress in analytical methods," J. Chernick (Atomics International); "Monte Carlo methods," R. Van Norton (New York University); and "Homogeneous System," N. Corngold (Brookhaven).

The last day of the conference was devoted to papers and discussion of reactor kinetics. The subject was introduced by M. M. Mills (University of California Radiation Laboratory), who presided over the morning and evening sessions. The following papers were presented: "Fast reactor kinetics," G. E. Hansen (Los Alamos); "Pulsed sources in fast assemblies," J. Bengston (University of California Radiation Laboratory); "Kinetics experiments, water boiler reactor," D. Hetrick (Atomics International); "An energy model for the initial behavior of SPERT I," G. W. Griffing and L. I. Deverall (Phillips); "Analysis of experiments involving reactor transients," A. F. Henry (Westinghouse Atomic Power Division); "Problems of theory and data, SPERT I," W. E. Nyer and S. G. Forbes (Phillips); and "Some problems in reactor stability," R. O. Brittan, J. Thie, and H. Greenspan (Argonne).

In addition to the formal papers presented, numerous discussions, both formal and informal, were held after the meetings and in the afternoons. Many conferees expressed the hope that this conference would be the first of an annual series to be held in southern Idaho.

P. W. Healy

Atomic Energy Division, Phillips Petroleum Company, Idaho Falls, Idaho

Solid-State Phenomena in Electric Circuits

A symposium entitled "The Role of Solid State Phenomena in Electric Circuits" was held at the auditorium of the Engineering Societies Building in New York City, 23–25 April. This symposium was capably organized by the Microwave Research Institute of the Polytechnic Institute of Brooklyn, in cooperation with the Institute of Radio Engineers and with the cosponsorship of the Air Force Office of Scientific Research, the Signal Corps Engineering Laboratories, and the Office of Naval Research.

The welcoming addresses contained the following highlights: a prophecy that the explorations in solid-state physics have thus far barely scratched the surface, an affirmation of the military necessity for the United States to lead in electronics, and the disclosure that the Government sponsors of the research programs which maintain this leadership are gratified by the surprising productivity of research in areas in which initial investigations appeared to hold no practical interest.

Here are a few extracts from notes and sketches made at the symposium. The state of development of the devices and other details will be found in the proceedings of the symposium, which will be published in the early fall.

Two forms of a modulator or variable attenuator for microwaves, which look similar but function quite differently, were announced by A. F. Gibson and J. W. Granville of the Radar Research Establishment in England (Fig. 1). In both cases, a thin slab of germanium is inserted in a wave-guide to attenuate the flow of power. The attenuation of this thin germanium slab can be varied either by (i) varying the concentration of current carriers or by (ii) varying the mobility of the current carriers. The population of minority carriers can be varied by means of an injecting contact at one end of the slab. In this case, the response time depends on the transit time of minority carriers across the slab, which is of the order of microseconds. The other method utilizes the fact that carrier mobility decreases with increasing electric field, and requires ohmic contacts at both ends of the slab. By the application of large amplitudes of voltage, the transmission of radiation is controlled. This method holds greater promise for high frequencies, because the response time is limited essentially by the dielectric relaxation time of the germanium (10^{-12} sec).

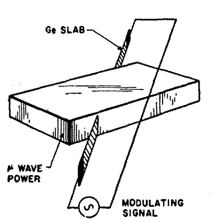
Although the Hall effect (Edmund Hall, of Harvard University) dates back to 1879, the recent interest in the III–V compound In Sb has brought to light several new applications. This compound yields a very large Hall voltage as a result of its unusually high mobility of electrons (67,000 cm^2/volt sec at room temperature). E. W. Herold, of the Radio Corporation of America, mentioned a gyrator circuit which employs the Hall effect (Fig. 2). The distinctive feature of this circuit is that it is a four-terminal network for which the reciprocity canon does not hold. Two other applications cited by Herold were a wattmeter and modulator.

A novel phonograph pick-up that utilizes the magnetoresistance of In Sb was described by T. S. Moss of the Royal Aircraft Establishment, England. The resistance of a sample of In Sb can be increased as much as 19 times in a magnetic field, and by means of this effect, as shown in Fig. 3, small displacements of the sample can be translated into a detectable electrical signal.

Another device, a photomagnetic rectifier, was announced by Moss (Fig. 4). Rectification ratios of $10^4/1$ have been obtained with experimental units. The operation is explained here in terms of an n-type semiconducting sample. With current directed from terminals 1 to 2, the holes generated by the light are deflected by the magnetic field to the region bounded by sandblasted surfaces, which capture holes and thereby restrict current in the direction from 1 to 2. On the other hand, with current directed from 2 to 1, the holes are deflected to the region bounded by etched surfaces which have little influence on hole current. Therefore, the semiconducting sample (Fig. 4) acts as a rectifier with the direction of easy flow from 2 to 1, as indicated by the circuit symbol

2 —▶|— 1

H. Kroemer, of the Radio Corporation of America, proposed a fused silicon-germanium junction transistor, which utilizes the difference in energy gap between silicon and germanium to obtain a high emitter efficiency. The electronic energy band scheme for this device is sketched in Fig. 5. The emitter efficiency of a p-n-p transistor is the ratio of emitter hole current to the total emitter current. Therefore, the structure shown in Fig. 5 has a high emitter efficiency because the barrier for hole current, which flows in the valence band, is substantially smaller than the barrier for electron current, which flows in the conduction band.



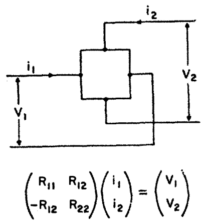
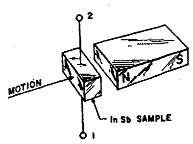


Fig. 1 (Left). Microwave modulator, or variable attenuator. Fig. 2. (Right). Schematic circuit diagram of the Hall effect gyrator. The Ohms law relation stated in matrix form indicates that reciprocity is violated.



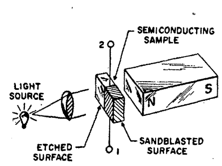
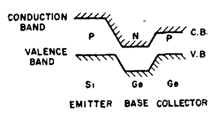


Fig. 3 (Left). Motion-sensing device employing magnetoresistance. Fig. 4 (Right). Photomagnetic rectifier.



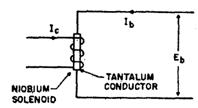


Fig. 5 (Left). Electronic energy band diagram of a high-gain silicon-germanium alloy transistor. Fig. 6 (Right). Circuit diagram of a cryotron.

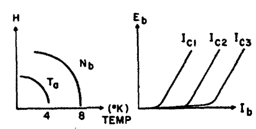


Fig. 7 (a) Critical temperature versus magnetic field. (b) Current-voltage characteristics.

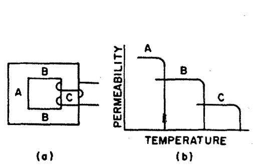


Fig. 8. High temperature inductor. (a) Schematic illustration. (b) Permeability versus temperature.

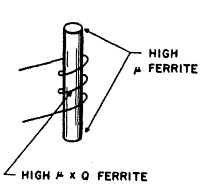


Fig. 9. Sensitive loop antenna.

It was pointed out that the cryostat has become a practical tool in many military applications. Among the devices which operate in cryostats are masers, transformers which operate both on direct current and alternating current, and cryotrons. Both M. Strandberg, of Massachusetts Institute of Technology, and J. O. Artman, of Harvard University, reported on solid-state maser amplifiers. Since these devices have been adequately treated elsewhere [J. Combrisson, A. Honig, C. H. Townes, *Compt. rend.* **242**, 245 (1956); N. Bloembergen, *Phys. Rev.* **104**, 324 (1956), J. P. Wittke, *Proc. I.R.E.* (*Inst. Radio Engrs.*) **45**, 291 (1957)], it should suffice to relate that they have already attained a twofold increase in radar sensitivity and have provided noise temperatures as low as 10°K.

H. O. McMahan, representing Arthur D. Little, Inc., pointed out that a transformer in which the secondary winding is a superconductor can transmit direct current as well as alternating current by virtue of the Meissner effect. The Meissner effect can be demonstrated by the following procedure: place a magnet on a lead plate and reduce the temperature below the critical temperature for lead (the temperature below which lead is a superconductor). As the temperature falls below the critical temperature, the magnet jumps up and floats in space above the plate. The explanation is that surface currents induced in the superconductor *completely* prevent the penetration of the magnetic field, and these induced currents do not damp out but persist indefinitely.

Both McMahan and Herold mentioned the cryotron (Fig. 6), a new solid-state amplifying device which operates in a cryostat at temperatures below 10°K and depends on the variations of the critical temperature of niobium and tantalum in a magnetic field (Fig. 7a). The current-voltage characteristics of the device are shown in Fig. 7b, and it may be seen that, in the language of the circuit engineer, the cryotron is a dual to the vacuum-tube triode. The resolving time of the cryotron depends on the ratio of the inductance of the cryotron to the resistance of the external circuitry. Switching speeds of 10^{-9} second have already been attained.

Herold cited circuit elements in which improvements in performance have been attained by means of inhomogeneous structures. Among the examples mentioned were the graded base transistor, a specially designed transmission line, a high temperature inductor, and a sensitive loop antenna. The high temperature inductor (Fig. 8) features a ferrite core blended in such a way that the ferrite with maximum Curie temperature is located in the hottest region, within the coil, and the coolest region, remote from the coil, employs a ferrite with low Curie temperature but high permeability. Thus, the temperature and effective permeability are optimized. The sensitive antenna (Fig. 9) is wound around a composite ferrite rod. The central section, which is closely coupled to the coil, is composed principally of low loss ferrite, whereas the composition at the ends of the rod gives way to a ferrite with high permeability. Thus, the over-all sensitivity is maximized.

The conference closed with a lively discussion on the future course of solid-state electronics by a panel of experts.

B. R. Gossick

Motorola, Inc., Phoenix, Arizona

Forthcoming Events

January

27–28. Scintillation Counter Symp., Washington, D.C. (G. A. Morton, Radio Corporation of America, Princeton, N.J.)

27–29. American Soc. of Heating and Air-Conditioning Engineers, Pittsburgh, Pa. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

27–30. American Meteorological Soc., 163rd natl., New York. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

27–31. Institute of Aeronautical Sciences, 26th annual, New York, N. Y. (S. P. Johnston, IAS, 2 E. 64 St., New York 21.)

28–30. Aging, 4th Ciba Foundation Colloquium (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

28–30. American Mathematical Soc., 64th annual, Cincinnati, Ohio. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

29–31. American Astronomical Soc., 4th annual, New York. (A. B. Crunden, AAS, 516 Fifth Ave., New York 36.)

29–1. American Physical Soc., annual, New York, N.Y. (K. K. Darrow, Columbia Univ., New York 27.)

30–31. College-Industry Conf., American Soc. for Engineering Education, 10th annual, Ann Arbor, Mich. (W. D. McIlvaine, College of Engineering, Ann Arbor.)

30–31. Mathematical Assoc. of America, annual, Cincinnati, Ohio. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

30–1. American Assoc. of Physics Teachers, New York. (F. Verbrugge, Univ. of Minnesota, Minneapolis.)

30–1. Western Soc. for Clinical Research, 11th annual, Carmel-by-the-Sea, Calif. (A. J. Seaman, Univ. of Oregon Medical School, Portland 1.)

31–1. Problems of Geriatrics, symp. (by invitation only), New York. (B. F. Chow, Johns Hopkins Univ., School of Hygiene and Public Health, 615 N. Wolfe St., Baltimore 5, Md.)

February

1–14. Pan American Assoc. of Ophthalmology, Caribbean cruise cong., sailing from New York, N.Y. (L. V. Arnold, 33 Washington Sq. W., New York 11.)

3–4. Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Del. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

3–7. American Inst. of Electrical Engineers, winter genl., New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

5–7. Biophysical Soc., Cambridge, Mass. (A. K. Solomon, Biophysical Lab., Harvard Medical School, Boston, Mass.)

10–14. American Soc. for Testing Materials, St. Louis, Mo. (F. F. Van Atta, ASTM, 1916 Race St., Philadelphia 3, Pa.)

13–15. National Soc. of Professional Engineers, spring, East Lansing, Mich. (NSPE, 2029 K St., NW, Washington 6.)

16–20. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New York. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

20–21. Transistor and Solid State Circuits Conf., Philadelphia, Pa. (J. H. Milligan, Jr., Dept. of Electrical Engr., New York Univ., New York 53.)

22–25. American Educational Research Assoc., St. Louis, Mo. (F. W. Hubbard, AERA, 1201 16th St., NW, Washington 6.)

24–28. American Soc. of Civil Engineers, Chicago, Ill. (W. W. Wisely, ASCE, 33 W. 39 St., New York 18.)

March

1. Junior Solar Symposium, Tempe, Ariz. (Association for Applied Solar Energy, 3424 N. Central Ave., Phoenix, Ariz.)

1–3. National Wildlife Federation, St. Louis, Mo. (E. F. Swift, NWF, 232 Carroll St., NW, Washington 12.)

3. Wildlife Soc., annual, St. Louis, Mo. (D. L. Leedy, U.S. Fish and Wildlife Service, Washington 25.)

5–6. Gas Conditioning Conf., 7th annual, Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

6–8. Fundamental Cancer Research, 12th annual, Houston, Tex. (W. K. Sinclair, M. D. Anderson Hospital and Tumor Inst., Univ. of Texas, Houston 25.)

6–8. Optical Soc. of America, annual, New York. (A. C. Hardy, Massachusetts Inst. of Technology, Cambridge 39.)

10–13. American Assoc. of Petroleum Geologists, annual, Los Angeles, Calif. (R. H. Dott, AAPG, Box 979, Tulsa 1, Okla.)

10–13. Society of Economic Paleontologists and Mineralogists, annual, Los Angeles, Calif. (R. H. Dott, Box 979, Tulsa, Okla.)

16–21. Nuclear Engineering and Science Cong., Chicago, Ill. (D. I. Cooper, *Nucleonics,* 330 W. 42 St., New York.)

17–21. National Assoc. of Corrosion Engineers, 14th annual, San Francisco, Calif. (NACE, Southern Standard Bldg., Houston 2, Tex.)

18–20. Amino Acids and Peptides, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

20–22. Michigan Acad. of Science, Arts and Letters, annual, Ann Arbor. (R. F. Haugh, Dept. of English, Univ. of Michigan, Ann Arbor.)

20–22. Pulmonary Circulation Conf., Chicago, Ill. (Wright Adams, Chicago Heart Assoc., 69 W. Washington St., Chicago 2.)

20–23. International Assoc. for Dental Research, annual, Detroit, Mich. (D. Y. Burrill, Univ. of Louisville, School of Dentistry, 129 E. Broadway, Louisville 2, Ky.)

23–26. American Assoc. of Dental Schools, annual, Detroit, Mich. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

23–29. American Soc. of Photogrammetry, 24th annual, jointly with American Cong. on Surveying and Mapping, 18th annual, Washington, D.C. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

24–27. Institute of Radio Engineers, natl. conv., New York. (G. W. Bailey, IRE, 1 E. 79 St., New York 21.)

27–29. National Science Teachers Assoc., 6th natl., Denver, Colo. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

29. South Carolina Acad. of Science, annual, Charleston. (Miss M. Hess, Dept. of Biology, Winthrop College, Clemson, S.C.)

29–30. American Psychosomatic Soc., 15th annual, Cincinnati, Ohio. (T. Lidz, 551 Madison Ave., New York 22.)

30–3. American College Personnel Assoc., annual, St. Louis, Mo. (L. Riggs, DePauw Univ., Greencastle, Ind.)

April

1–3. Corrosion Control, 5th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

2–4. American Assoc. of Anatomists, annual, Buffalo, N.Y. (L. B. Flexner, Dept. of Anatomy, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

2–4. Instruments and Regulators Conf., Newark, Del. (W. E. Vannah, Control Engineering, 330 W. 42 St., New York 36.)

4–5. Southern Soc. for Philosophy and Psychology, annual, Nashville, Tenn. (W. B. Webb, U.S. Naval School of Aviation Medicine, Pensacola, Fla.)

7–11. American Assoc. of Cereal Chemists, annual, Cincinnati, Ohio. (J. W. Pence, Western Utilization Research Laboratories, Albany, Calif.)

8–10. Electronic Waveguides Symp., New York. (J. Fox, Microwave Research Inst., Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.)

9–12. National Council of Teachers of Mathematics, Cleveland, Ohio. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

(See issue of 20 December for comprehensive list)