den), and the chemistry of the compounds was discussed by Werdinius (Gôteborg). The method requires great care, and various laboratories find different modifications necessary for optimal results. R. L. Smith (St. Mary's) presented the modifications necessary for application to adipose tissue.

In a review of the pharmacology of the catecholamines, Costa (National Institutes of Health) presented a working theory of the interaction of the mediators, monoamine oxidase, the inhibitors, reserpine, and other drugs. The theory provides a good picture of the current state of the art. Spectrofluorometric techniques are used in much of this work.

Bowman concluded the lecture sessions with some discussion of new techniques utilizing low-energy electrons to excite fluorescence and suggested that new advances in fluorescence techniques are just as likely to develop from experimentation as from analysis of the complex theoretical possibilities.

The institute is now examining the possibilities of holding another session within the year for the more than 100 qualified applicants who could not be accommodated in this session.

ROBERT L. BOWMAN
National Institutes of Health, Bethesda 14, Maryland

High Magnetic Fields: Production and Application

In the evolution of research, cross divisions of science sometimes arise which are based on specialized objectives or experimental techniques. Such research areas cut across the time-honored, historic, or pedagogic divisions of science and are often reabsorbed into these after a more or less brief period of vigorous progress and cross-fertilization. The field of low-temperature physics has enjoyed such a transient existence during the past decade or two, and high magnetic-field research, a closely related area, appears to be following. The environment of low temperature and high magnetic field actually have a great deal in common. Both are of value largely because they are conducive to minimum entropy, and each environment is helpful, if not necessary, in generating the other. The community of high magnetic-field research had its formal birth at the first international conference, held at Massachussetts Institute of Technology in November 1961. The second such conference was held at Oxford University 10–12 July 1963, and it appears quite likely that these events will become biennial and follow the pattern of the one in low-temperature physics.

The conference was opened by Bitter and Montgomery who described the recently dedicated M.I.T. National Magnet Laboratory, sponsored by the U.S. Air Force. The laboratory represents the first cooperative effort in this area of research and is expected to do for various branches of atomic physics what Brookhaven and similar institutions have done for nuclear physics. It will not only provide very high fields as a research environment but will also serve as a center for advancing the art of generating high magnetic fields. This facility is based on a family of high-performance, reinforced copper solenoids, water-cooled, and supplied by an 8-megawatt power plant capable of 32-megawatt overload operation. It is flexibly arranged to accommodate many simultaneous experiments and will supply continuous fields up to 250 kilogauss and 2-second fields up to 400 kilogauss. These reports as well as others from Leiden University, Oxford University, the Royal Radar Establishment, and the Lewis Research Center of NASA in Cleveland indicate that conventional (normal conductor) magnets are still the object of a great deal of sophisticated work and are likely to continue as the principal tool for generating high fields for many years to come.

The science and technology of superconductivity formed at least half of the subject matter of the conference. Compared to other conferences devoted specifically to this topic, emphasis at Oxford was phenomenological. The topic was ably introduced by Berlincourt of Atomics International, who summarized what little progress appears to have been made during the past two years. Composite materials containing niobium-tin as a core or diffusion layer still appear to have the most promising properties, just as they did 3 years ago. However, the technical difficulties involved in reacting these materials at 1000°C *in situ* and subsequently immobilizing them have caused almost universal abandonment of composite materials in favor of the less promising, though less problematic, alloy materials, notably niobium-zirconium. About half a dozen commercial organizations now sell niobium-zirconium alloy, and a comparable number of organizations are marketing niobium-zirconium solenoids supplying fields of up to 60 or 70 kilogauss. Much has been learned about the motion of magnetic flux through hard or magnetically permeable superconductors to explain many of the originally baffling phenomena. In particular, magnetization measurements have indicated that the instability of the current-carrying state in hard superconductors (the mysterious "coil degradation") is predominantly a thermal effect related to the release of magnetic energy when transport currents destroy magnetization currents.

In the light of some very recent success with composite materials, it appears regrettable that this facet of superconductivity has been virtually abandoned for at least 2 years. It is perhaps one of the adverse effects of modern communication among investigators. The outstanding bit of news at the conference was undoubtedly from the General Electric group which described a niobium-tin solenoid capable of generating 101 kilogauss. This is the first report on such a magnet since the early attempts at Bell Telephone Laboratories and M.I.T. more than 2 years ago. Although little detail concerning the material was given, the work is bound to stimulate workers to give more attention to composite superconductors. Two groups are, in fact, working along similar lines: Saur (University of Giessen, Germany) and collaborators reported systematic studies of vanadium-gallium and silicon systems, and Stauffer (National Research Corporation) reported on a metallurgical process leading to a new composite niobium-tin material. From the viewpoint of high magnetic-field research, superconducting magnets at present appear most promising as supplementary solenoids surrounding conventional magnets. Problems of force containment and heat removal remain to be solved. The former are receiving attention by Wakefield and collaborators at Princeton University and Boom at Atomics International, where a study of force-free structures is being continued. The problem of cooling large structures has thus far received essentially no attention. A feasibility study by Stekly (Avco) indicates that when suitable materials become available, the generation of 500 kilogauss is structurally possible in simple solenoid design. Two methods were described for solving the difficult current supply problems in large superconducting solenoids. Volger and Van Suchtelen (Phillips Research Laboratory, Netherlands) described an ingenious superconducting generator without moving parts, and Laquer (Los Alamos) described an electrical-flux pumping method. General progress, trends, and future prospects were discussed in an unusually lively ad hoc session.

Regardless of whether or not superconducting solenoids will ultimately replace normal ones, solid-state research in high magnetic fields continues at an increasing rate.

For the purpose of this conference, solid-state research was divided into two parts: (i) metals and magnetic materials in high magnetic fields and (ii) semiconductors in high magnetic fields. The keynote speech on the first of these subjects was delivered by A. B. Pippard (Cambridge). He discussed in physical and pictorial terms the measurement of conduction electron motion in a magnetic field. Particular emphasis was given to the high field phenomenon of magnetic breakdown, which becomes important when the magnetic energy $\hbar\omega_c$ becomes comparable to the energy band gap E_g. In this limit, the two adjacent energy bands become strongly coupled by the magnetic field. Those electron trajectories corresponding to open orbits can then carry current by transmission through the zone boundaries and, in fact, dominate the conductivity in the high field limit. An experimental illustration of the magnetic breakdown phenomena was presented by J. M. Reynolds (Louisiana State University) in galvanomagnetic measurements on Zn and Sn, materials which have small band gaps.

Considerable progress has been made recently in the application of magnetoresistance experiments and of the De Haas van Alphen effect measurements to study the topology of the Fermi surface of metals. Interesting magnetoresistance results in fields up to 100 kilogauss were reported on the transition metals by Fawcett (Bell Telephone Laboratory). De Hass van Alphen results in the alkali metals were presented by Shoenberg and Stiles (Cambridge University), who used a novel modulation technique, and by Okumura and Templeton (National Research Council, Ottawa). Small departures from a spherical Fermi surface were found for the alkali metals. The possibility of observing the De Haas van Alphen oscillations in alloy systems (Au-Zn) is also quite exciting.

The use of high magnetic fields to study magnetism attracted attention. Wohlfarth (Imperial College, London) challenged the experimentalists to produce density of state curves for magnetic materials, while Jacobs (General Electric Laboratory, Schenectady) confronted the theoreticians with the intricacies of magnetization studies of several antiferromagnetic systems.

The introductory talk by R. J. Elliott (Oxford) not only summarized high field research in semiconductors but also covered the use of high magnetic fields to study crystals and cooperative magnetism. The contributed papers on semiconductors were largely concerned with magneto-optical measurements and calculations. Optical studies on the metal silver were reported.

The realm of high magnetic-field research, in fact, is by no means limited to solid-state physics. One of the more exotic applications of magnetic fields concerns the search for ferromagnetically trapped Dirac monopoles. None have yet been found by this or other means. Perhaps the next international conference on high fields will feature the finding of both monopoles and megagauss.

The conference was sponsored by the Institute of Physics and the Physical Society (of Great Britain), and organized by a committee comprising Kurti and Bagguley (Oxford University), Chester (Central Electric Research Laboratories, Leatherhead), and Parkison (Royal Radar Establishment, Malvern). Complete proceedings will not be published, but the four invited introductory papers and a summarized report of the conference by M. Lock (Royal Radar Establishment) will appear in the *British Journal of Applied Physics.*

HENRY H. KOLM
Massachusetts Institute of Technology, National Magnet Laboratory, Cambridge 39
MILDRED S. DRESSELHAUS
Massachusetts Institute of Technology, Lincoln Laboratory, Lexington 73

Forthcoming Events

October

17–18. American Soc. of **Tool and Manufacturing Engineers,** Pittsburgh, Pa. (H. E. Conrad, 10700 Puritan Ave., Detroit, Mich.)

17–19. Society of **Photographic Scientists and Engineers,** Washington, D.C. (E. Ostroff, SPSE, Box 1609, Main Post Office, Washington, D.C.)

17–20. **British Medical Assoc.,** annual clinical meeting, Stoke on Trent, Eng-