voted to semiconductors and one to ferroelectrics. These materials are of interest not only because of their technological importance, but also because much progress has been made in recent years toward an understanding of their unusual properties in terms of their atomic structure. Each of the three speakers, Karl Lark-Horovitz of Purdue University, John Bardeen of the Bell Telephone Laboratories, and Arthur von Hippel of the Massachusetts Institute of Technology, reviewed some aspects of research done by the groups with which they are associated.

Lark-Horovitz (who is secretary of the AAAS) traced the history of our knowledge of semiconductors and showed how the electrical properties can be understood in terms of the concentrations and mobilities of the current carriers. He presented some interesting data on effects of radiation on the conductivity of germanium. Acceptor type impurity levels are introduced in two different ways: by displacement of atoms from their normal lattice positions as a result of elastic collisions with fast incident particles and by transmutation. Prolonged exposure of germanium in the nuclear reactor at Oak Ridge leads to the formation of gallium atoms in lattice positions by capture of slow neutrons and subsequent beta decay. Gallium, having one less valence electron than germanium, acts as an acceptor impurity, and the concentration may be sufficiently large to produce marked changes in conductivity. A brief discussion was given of the high transparency of germanium and silicon in the infrared region beyond the fundamental absorption bands.

Research at the Bell Telephone Laboratories associated with the development of the transistor has shown that the concentration of current carriers, and thus the conductivity of a semiconductor, can be altered by current flow. For example, positively charged holes can be introduced into n-type germanium in which the carriers normally present are conduction electrons. The space charge of the added holes is compensated by an increase in the concentration of electrons. Bardeen discussed the flow of electricity in semiconductors in which appreciable numbers of both holes and electrons are present. The importance of both electric fields and concentration gradients in determining the flow was illustrated by several examples.

Ferroelectrics are materials in which domains are electrically polarized. They exhibit hysteresis effects in electric fields similar to those of ferromagnetic materials in magnetic fields. Examples are Rochelle salt, potassium hydrogen phosphate, and barium titanate. The latter material has been extensively investigated by von Hippel's group at MIT as well as at other laboratories, originally because of its high dielectric constant and more recently because of its importance as a ferroelectric and piezoelectric material. Von Hippel described research on the domain structure of single crystals of barium titanate. He showed very beautiful pictures of domains observed by P. W. Forsbergh, Jr. and designated by such descriptive terms as "church window patterns" and "Persian carpet patterns." Barium titanate is of interest from a theoretical standpoint because its structure is simpler than that of other ferroelectrics.

—J. Bardeen

ELECTRONS, COSMIC RAYS, AND FLASH BULBS

In the AAAS session on elementary particles, P. Kusch, who gave a very good discussion of the electron's magnetic moment, had the added distinction of being the only speaker who talked about elementary particles. The audience was only a little distracted by the continual flashing of newspapermen's flash bulbs until the end when a lantern slide was obscured by the photographic equipment in transit. A lively discussion afterwards was initiated by K. K. Darrow's comments about the "heuristic" nature of the theory which predicts the added moment of the electron. In defending the theorist's position Professor Breit pointed out that the theory that gave the right answer was one of the simpler forms but admitted that another answer could have been obtained if it were necessary.

J. C. Street presented a very well organized summary of our knowledge of cosmic rays at the present time. His general viewpoint was that we are in possession of enough facts about cosmic radiation to be able to give a qualitative explanation of almost all of the phenomena that are observed, even though this explanation may not be correct in detail. His lucid description of the birth and death of mesons stimulated the audience (most of whom were not physicists) and gave them some understanding of this important phase of physics. He showed a beautiful collection of slides from laboratories throughout the world to demonstrate the important discoveries.

In my talk I tried to summarize the work at Minnesota and to review the present knowledge about heavy nuclei in primary cosmic rays. We talked a little about the conditions the heavy nuclei impose on any theory about the origin of cosmic rays. Professor Korff suggested in the discussion that, even though one found an explanation for the origin of heavy nuclei, two separate mechanisms might be necessary to account for all the primaries. Professor Vallarta discussed the similarity of the energy spectrum of the protons and the heavy nuclei. Anyone who talks about cosmic rays in the future can amuse the audience with this Darrow quotation. "Millikan used to think that cosmic rays were the 'death-cries' of atoms and now we find that they are the atoms themselves."

—E. P. Ney

MICROSCOPY WITH X-RAYS

EXPERIMENTAL INSTRUMENT MODELS DESCRIBED

Reports from Stanford University and the General Electric Research Laboratory give new encouragement to the hope that some form of the x-ray microscope may one day be able to compete on a mature level with its older cousins, the light microscope and the electron microscope. The familiar optical microscope is limited to describing very thin and transparent specimen samples, or simply the surfaces of objects. The electron microscope, while capable of much higher magnifications, is also severely limited in that specimens to be examined must be prepared as extremely dry, thin slices which must furthermore be studied under conditions of high vacuum.

Although still in the laboratory stage, the x-ray microscope holds promise of far greater flexibility in that it is capable of penetrating beneath surfaces and need not be operated in a vacuum. One result of this may be that it will ultimately be used to examine living biological specimens, a region that has never been touched in microscopy except in the case of exceedingly small and transparent organisms.

Paul Kirkpatrick of Stanford reported at the West Coast meeting of the Physical Society in December that magnifications of from fifty to one hundred diameters had so far been obtained with a model which he and A. V. Baez, now of the Cornell Aeronautical Laboratory, had developed. A few weeks earlier, during the Philadelphia meeting of the American Society for X-Ray and Electron Diffraction, Charlys M. Lucht of the GE Research Laboratory described another test model which has provided magnifications of about ten diameters.

Magnified x-ray photographs of objects are made possible in principle because x-rays can be reflected from polished surfaces, provided that the beam strikes the reflecting surface at a very small angle—almost parallel to the surface. Present models make use of an x-ray tube with a chromium target as a source of soft x-rays, and because these would otherwise be absorbed in air, the entire system is enclosed in helium. The short wavelength of hard x-rays, it is pointed out, makes them unsatisfactory for microscopic purposes because small biological specimens would be invisible to hard x-rays. The beam, after passing through the specimen, strikes successively two curved, reflecting mirror surfaces that bend the x-rays in such a way that a magnified image of the specimen is cast on a photographic plate.

While magnifications up to one hundred diameters are be no means remarkable in any comparison with other types of microscopes, there seem to be strong indications that the major obstacles in the way of reaching higher magnifications are technical and may be expected to be overcome. Outstanding is a need for better quality mirror surfaces. Present mirrors have been made in a variety of ways: those used in the Stanford microscope have been prepared by piling up evaporated metal on a spherical surface or by direct grinding and polishing of glass, while those used at GE are platinum-coated slabs of fused quartz, which are nearly as flat as surfaces can be made. These are curved by mechanical pressure, which can be easily adjusted for better focusing.

Dr. Kirkpatrick and Miss Lucht both have reported that the current models show a resolving power that is encouragingly high, permitting the magnified images to be considerably enlarged without serious loss of detail.

HIGH FLUX

CHALK RIVER ISOTOPES AVAILABLE

Canada has joined the United States and Great Britain in making radioisotopes available for domestic distribution and export, according to a report from Ottawa. The U. S. AEC has announced that procedures have been developed in cooperation with the Department of State that will enable qualified American applicants to obtain Canadian radioisotopes on the same basis as applications for domestically produced materials. The high flux of the Chalk River pile permits the preparation of certain isotopes in greater concentrations than are available from other sources, and the Canadian materials will be especially valuable in research which demands isotopes with a higher activity than have been more generally available. Detailed information on procedures for obtaining Canadian isotopes is available from the Isotopes Division at Oak Ridge.

SOCIETY ACTIVITIES

OSA NATIONAL OFFICERS ELECTED

The Optical Society of America, which holds an election of national officers every two years, announced the results of last year's letter balloting at the annual meeting in Buffalo, and the newly elected officers formally took office at the close of that meeting. William F. Meggers, the previous vice president and chief of the spectroscopy section of the National Bureau of Standards, has been elected president. The new vice president is Brian O'Brien, director of the Institute of Optics at the University of Rochester; Arthur C. Hardy and W. W. Graeper were continued in office for additional four-year terms as secretary and treasurer respectively.

At the same time announcement was made of George R. Harrison's resignation as editor of the Journal of the Optical Society of America, a post he has held for the past ten years. His successor, appointed by the board of directors of the society, is Wallace R. Brode, associate director of the Bureau of Standards. The number of directors-at-large was formally reduced from five to four, and the office of secretary for local sections was made an elective post, the present incumbent being a voting member of the board of directors. Stanley S. Ballard of Tufts College was elected to this office for a two-year term. John Strong of the Johns Hopkins University and Mary E. Warga of the University of Pittsburgh were elected to serve for the next four years as directors-at-large. The retiring president of the Optical Society, Rudolf Kingslake, will serve on the board as past president. The regular winter meeting of the Society will be held at the Hotel Statler from March 9 to 11.

FELLOWSHIPS OFFERED

MIT SUMMER PROGRAM

Science teachers in preparatory and high schools in the United States have been invited to apply for fellowships in connection with the six week summer program to be held at the Massachusetts Institute of Technology beginning July 5, 1950. The fellowship program, which has been made possible by a grant from the Westinghouse Educational Foundation, will provide 50 science teachers with an opportunity to review in a broad and general way the fundamental sciences and to survey recent scientific advances.

Because of the limited number of grants and dormitory facilities available, application for the program must be received by April 1, and should be addressed to Professor Francis W. Sears, chairman of the summer program for Science Teachers Committee, MIT, Cambridge, Massachusetts.