the particle-size distribution and theoretical scattering functions. Since the light-scattering itself was insensitive to particle-size distribution over the range studied (r = 200–800 mμ) the particle size could not be determined from light scattering, but there was an optimum size-range around 55 mμ for which this was possible. Prof. F. K. Gucker and R. L. Rowell (Indiana University) had succeeded in determining the light-scattering diagrams of single aerosol droplets by first charging and suspending them in an electric field, illuminating them with monochromatic light and measuring the light scattered into a photometer over the arc 40–140° from the direction of illumination. Good agreement was obtained with calculations based on the Mie theory. The effect of particle separation on the light-scattering properties of monodispersed spheres was investigated by Prof. S. W. Churchill (University of Michigan), G. C. Clark (Continental Oil Co., Ponka City, Oklahoma) and C. M. Sliepcevich (University of Oklahoma) by measuring the transmission of light through a hydrosol of latex spheres as a function of the particle concentration. According to their measurements, optical interference between the particles is negligible when their average separation exceeds 1·7 particle diameters.

The wide scope of the conference was epitomized in the last two papers, representing meteorology and fuel technology. Dr. C. L. Hosler and Dr. R. E. Hallgren (Pennsylvania State University) described how the aggregation of small ice crystals was affected by their shape, and particularly by the air temperature; Dr. R. H. Essenhigh and Dr. I. Fells (University of Sheffield) presented a mathematical theory of the combustion of liquid and solid aerosols.

The conference enjoyed the generous hospitality of the University of Bristol and the excellent facilities of the new Queen's Building. One's main regret was that the Russian contributors were not there to present and discuss their four papers. B. J. MASON

PHYSICS OF SEMICONDUCTORS

AN international conference on the physics of semiconductors, sponsored by the International Union of Pure and Applied Physics and arranged by the Czechoslovak Academy of Sciences, was held in Prague during August 29–September 2. In recent years this has become a biennial conference, the previous one having been held in Rochester, New York (*Nature*, **108**, 1067; 1958), in August 1958, and it is proposed that the next of the series should be in Britain in 1962. The present conference showed clearly that semiconductor physics still represents a very active and indeed an expanding field of research. It is, of course, unwise to judge only by the numbers of papers submitted or by the number of physicists attending the conference; but this gives some indication, and was supported by the fact that new ideas emerged and many new and exciting developments were reported. Indeed, the chief problem which had to be faced by the organizers was that of selecting from the large number of papers submitted. Approximately 265 papers were selected for inclusion in the conference proceedings, of which only about half were actually read. The geographical division of these papers is of some interest; approximately 110 originated in the United States, 40 in the U.S.S.R., 22 in Germany, 20 in Great Britain, 15 in France, 14 in Czechoslovakia, 9 in Poland and 7 in Japan, the remainder being distributed over a large number of participating nations.

The number of physicists attending was much larger than for any previous conference of the series, being nearly 750. As a result, it was necessary to divide the conference into four parallel sessions, three of which were run on the normal pattern of papers followed by discussions and one using *rapporteurs* followed by discussion. In the former, translations into Russian, Czech and English were available, though the English translations were frequently very difficult to follow. The chief drawbacks of the conference arose from its large size, there being many overlapping papers of interest, and it is hoped that future conferences will revert to a smaller and more intimate form.

It is impossible in the space available even to mention all the interesting topics discussed at the conference, and only a few of the highlights can be selected that left the most vivid impressions in the memory. Introductory papers were given by (the late) A. F. Joffe and by W. Shockley. The former stressed the urgent need for a new theoretical approach to the problem of low-mobility semiconductors for which conventional theory based on a nearly perfect crystalline lattice is clearly inapplicable, the mean free path for current carriers being comparable with the lattice spacing. Various discussions based on 'electron hopping' were later given; but it is clear that a lot more work is required before these processes are as well understood as transport phenomena in high-mobility semiconductors. Later in the conference Joffé discussed some of the difficulties associated with the understanding of thermo-electric phenomena in semiconductors. In his introductory paper Shockley discussed a wide variety of phenomena associated with avalanche breakdown in p–n junctions induced by high electric fields, and introduced some new theoretical ideas which might lead to a better understanding of these complex phenomena.

Discussion of transport phenomena again dominated the conference, there being no less than 48 papers submitted on this subject, dealing mostly with silicon and germanium, which remain the basic semiconductors for the study of fundamental phenomena. C. Herring (United States) reviewed developments in the theoretical formulation since the Rochester conference and directed attention to some recent clarification of the difficult problems associated with multi-phonon scattering, and of scattering of carriers in the presence of strong magnetic fields. Two interesting new experiments on transport stood out. The first was described by W. Shockley and K. Hubner (United States) in which an n-p-n structure was used to demonstrate phonon drag on electrons. Some electrons given momentum by an electric field applied in one n-type region pass into the p-type region where they are scattered, producing phonons with a preponderance of momentum in

the same direction; these diffuse into the second n-type region producing an observable e.m.f. through making collisions with electrons. The second experiment, described by T. P. McLean and E. G. S. Paige (Great Britain), consisted of demonstrating by means of measurements of drift mobility at low temperatures an important drag effect of the majority carriers on the minority carriers. A number of papers dealt with the variation of mobility with temperature and it was clear that in spite of the large amount of work carried out in this field there are still aspects of it which are not properly understood. A considerable number of papers dealt with 'hot' electrons produced by strong electric fields.

Perhaps the outstanding new development reported at the conference was the use of the phenomenon of quantum-mechanical tunnelling, discovered by L. Esaki, as a tool for the study of some of the fundamental properties of semiconductors. By a combination of theory with the study of the voltage-current characteristics of 'tunnel' diodes, it was shown by R. N. Hall (United States) that much valuable information may be obtained on the phonon energies associated with the band edges of semiconductors such as germanium, and also possibly on polarons in partially polar semiconductors such as the 3–5 compounds. There was, however, some doubt cast, particularly by E. O. Kane (United States), on some aspects of the interpretation of the experimental data.

The optical properties of semiconductors again gave rise to a considerable number of papers (45 if we include photoconductivity), and, as at Rochester, a discussion of excitons played a prominent part. The experiments of S. Nikitine (France) and of E. F. Gross and his colleagues (U.S.S.R.), particularly with cuprous oxide, seem now to be well understood in terms of the theory of R. J. Elliott (Great Britain), an excellent example of international co-operation. The paper by Gross and his colleagues stressed, however, that there is still no convincing direct evidence for exciton transport though its deduction from theory is beyond doubt. They described various optical effects which they have observed in cuprous oxide and which are a consequence of the fact that an exciton is free to move. (The form of the exciton spectra in indirect transitions in germanium and silicon reported at Rochester are also a consequence of the freedom of the exciton to move.) Optical effects in magnetic fields discussed by B. Lax (United States) and others have continued to provide a powerful tool for the investigation of the band structure of semiconductors. Work on the lattice vibrational spectrum of semiconductors is becoming of first importance, and interesting new results were reported by F. A. Johnson (Great Britain). In particular it is of considerable theoretical interest that the $T.A.$ mode in 3–5 compounds such as indium antimonide has a low energy at the zone edge as for silicon and germanium. Surprising new effects in the absorption associated with the *reststrahl* band in gallium arsenide were also reported by Johnson. Emission of radiation due to inter-band transitions with various phonon combinations reported for silicon by J. R. Haynes, B. Lax and W. F. Flood (United States) and for germanium by Benoît à la Guillaume and O. Parodi (France) threw new light on these processes, especially when taking place by means of an impurity centre, and also provided very accurate values for various energies associated with the phonon spectrum. Further information on the band structure of germanium–silicon alloys and of a number of 3–5 compounds was obtained from the accurate measurement by J. Tauc (Czechoslovakia) of optical reflectivity in the visible and near ultra-violet regions of the spectrum. In particular, fine structure was observed which could be interpreted as due to the spin-orbit splitting of the valance band at the zone edge. At the other extreme, photoconductivity was reported in indium antimonide in a magnetic field at 1·7° K., by R. A. Smith (Great Britain), extending throughout the far infra-red spectrum to wave-lengths beyond 2,000μ.

A considerable number of papers was devoted to the study of ionic crystals and this widened considerably the scope of the conference. In the sessions on new materials, the 3–5 compounds received a good deal of attention, but organic semiconductors were also discussed by C. G. B. Garrett (United States) and an interesting group of defect compounds such as In_2Te_3 by V. P. Zuze and his colleagues (U.S.S.R.).

Perhaps the most mysterious phenomenon discussed without reaching a satisfactory explanation was the occurrence of oscillations in n-type germanium and indium antimonide carrying a current in a longitudinal magnetic field. These appear to be due to plasma effects and were described by P. Aigrain (France) in terms of 'helicons'. Such topics for argument gave spice to what was in any event a very stimulating and thought-provoking conference, which was concluded by an excellent summary of the highlights by J. Tauc. This summary was of the greatest help in preparing this report. The conference papers will be published by the Czechoslovak Academy of Sciences in due course.

R. A. SMITH

ERGONOMICS IN INDUSTRY

A CONFERENCE on ergonomics in industry, organized by the Department of Scientific and Industrial Research, was held in the Connaught Rooms, Great Queen Street, London, during September 27–29. It was attended by more than three hundred representatives of some two hundred industrial firms. The purpose of the conference was to explain the features of ergonomics, to describe some of the ways in which it has already been applied to industry, and to discuss the possible ways in which further use of ergonomic techniques and ideas could be promoted.

Sir Harry Jephcott, chairman of the Council for Scientific and Industrial Research, introducing Lord Hailsham, Minister for Science, who formally opened the conference, said that it was the logical development of a meeting held in March 1959 in Zurich organized by the European Productivity Agency, and entitled "Fitting the Job to the Worker". At Zurich there were three groups, representing manage -