base. A freshwater research substation is now being established at Birnin Kebbi in Northern Nigeria.

Research is being done on the hydrology and biology of the Freetown estuary, with special reference to the fisheries, and a routine trawling survey from the motor launches is in progress. There is a very varied fauna of fish and invertebrates on bottoms of sand, shells, gravel and fine mud. Studies of bottom soils include estuarine muds and mangrove swamps, and a start has been made on the physical, chemical and biological changes which follow the empoldering and draining of such swamps.

With the large research vessel, a trawling and hydrographical survey of the seas lying off the British West African territories has begun, but has been interrupted by mechanical defects in the research trawler. Trawling was carried out to depths greater than 100 fathoms, where little or no fishing has hitherto been done. When the research trawler returns to service, these long-range surveys will be done throughout the year.

A little work has been done on the freshwaters of Sierra Leone; these are of an acid character and the territory as a whole is deficient in lime.

The Northern Rhodesia-Nyasaland Joint Fisheries Research Scheme has to cover waters separated as widely as Lake Tanganyika in the north, Lake Nyasa in the east, the Zambesi and Kafue Rivers in the south, and Lakes Bangweolo and Mweru, with their swamps, and the Luapula River, in the south and west. Consequently, though its headquarters will be on Lake Bangweolo, at Samfya, where a laboratory and houses are being built on a bluff overlooking the lake, the research unit must be mobile. This autumn it is starting a two-year survey of Lake Nyasa. Buildings are being prepared, and a research launch acquired. The scientific officer in charge is Mr. P. B. N. Jackson, and there is an establishment of three research officers.

At an earlier stage of development are the Marine Research Stations at Singapore and Hong Kong. Dr. F. D. Ommanney is director of the Singapore station, and Mr. J. A. Tubb is director of the Hong Kong station. The building of a laboratory and houses at Singapore has been delayed; a research vessel is being sought. Two of the establishment of three research officers are in training; one has recently undertaken a short mission to Barbados to study the fishing for flying-fish. The Research Station at Hong Kong is in association with the Department of Zoology of the University of Hong Kong, and will be staffed by graduates of that Department. A small research vessel has been laid down. Finally, provision has been made for a station for fundamental research into fish farming. A suitable site has yet to be found.

The Research Stations at Jinja (freshwater) and Zanzibar and Freetown (marine and brackish water) are now in operation, and provide research facilities for visiting workers, who will be welcomed. In certain cases, a part of the expenses (except salary) of a visiting scientist can be defrayed from funds available to the Research Stations. These Stations, being situated where seasonal changes are slight by comparison with temperate climates, and where there is a very wide range of ecological conditions, offer unusually good research opportunities. Applications and requests for information should be addressed, either to the Directors, or to the Fisheries Adviser, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

INTERNATIONAL CONFERENCE ON THEORETICAL PHYSICS MEETING IN JAPAN

I BELIEVE that the proposal to hold a conference in Japan under the auspices of the International Union of Physics was first made at the General Assembly of the Union in Copenhagen during 1951; certainly the proposal had the strong support of the late president of the Union, Prof. H. A. Kramers. Suggestions were originally made for a conference of rather limited scope, on statistical mechanics or on field theory; but it seemed to everyone concerned that this, the first important conference on physics ever to be held in Japan and the first real opportunity for Japanese physicists to meet those of other countries, should cover a much wider field. It was decided in the end to arrange a conference to include most branches of theoretical physics on which work is being done in Japan, including field theories, meson theories, molecular structure and the physics of the solid state, and also to hold the annual executive committee meeting of the Union in Tokyo on the same occasion.

The conference was organized by the Science Council of Japan, with the collaboration of Kyoto University where the main sessions were held, and by the Physical Society of Japan. About sixty physicists from outside Japan attended, including thirty from the United States, six each from France and Great Britain, and others from Australia, Belgium, Denmark, Germany, India, Italy, Korea, Mexico, Netherlands, Sweden and Switzerland. About ten times as many Japanese physicists took part. Much of the heavy cost of bringing the foreign scientists to Japan was defrayed by special grants from Unesco and from the Rockefeller Foundation, while arrangements were made by the United States Government Agencies for bringing most of the scientific workers from that country. Within Japan, the cost of living and of travelling from place to place was borne by the organizers of the conference, money being contributed by the Japanese Government, by industry and commercial organizations, by newspapers and by many private individuals.

The main conference opened in Tokyo with a formal session, the delegates then travelling to Kyoto for the scientific meetings. These were held in three sections in parallel, the first on nuclear physics and field theory, and the other two covering various aspects of molecular physics, statistical mechanics and the physics of the solid and liquid states. In addition, more limited symposia were held in Kyoto and other centres, and in hotels in holiday resorts, on nuclear resonance phenomena, polymers, dislocations, latent image theory and on liquid helium, to mention only some of them.

The discussions on field theory and nuclear physics were attended by the largest numbers, both of Japanese physicists and of the visitors from other countries. (I am indebted to Prof. R. E. Peierls for a description of the work in this section.) For the visitors the most important result of the conference was that they learned to understand the ideas behind some outstanding Japanese papers that they had seen in print but had not adequately compared with their own methods. Probably the experience was mutual. It is, of course, a difficult time for field theory, since we are in doubt about the basic equations and are also without sufficiently powerful methods of solving

them to be sure of their consequences. There was naturally much discussion on methods of approximation, including the idea that, for an approximate meson theory of nuclear forces, one should treat the interaction at large and at small distances differently. At small distances a 'phenomenological treatment' might suffice, whereas at large distances conventional perturbation theory might be reasonably good. Such an approach was first proposed in Japan by Taketani and his collaborators, and later developed independently and more extensively by Lévy at Princeton. Other novel approximations which were discussed included an application by Tomonaga and others of his 'intermediate coupling' method to scattering problems, a new use of variational methods by Sawada, and an attempt by Brueckner, in describing the nucleon-meson interaction, to allow for the distortion of the meson wave by the presence of the nucleons. Some time was devoted to up-to-date reports on the experimental situation both in nucleon-nucleon interactions and on new elementary particles. It is evident that there is a wide range of facts to be described by a complete theory, but as yet no real clue as to how to construct one. New attempts to modify the theory included Yukawa's 'non-local' theory which contains for each field 'internal' as well as the ordinary space-time co-ordinates, and this gives one freedom to describe many types of particles in the same field. However, the theory is still too general to give specific results, and it also contains troublesome infinite degeneracies.

Another interesting modification proposed by Pais also uses additional variables; but these relate not to a second four-dimensional space-time but to the surface of a sphere, the rotations of the sphere being connected with isotopic spin. In this way one finds these rotations and the isotopic spin combining like ordinary angular momentum and spin, and this suggests a classification of some of the recently discovered particles. One may then interpret the absence or weakness of some processes not otherwise forbidden by a parity selection rule in this new space.

There was some discussion of theories with 'non-local interactions' in which one tries to avoid singularities by replacing the usual point interaction by actions over small but finite distances. Reports by Møller, Peierls and C. Bloch led to the conclusion that none of the existing forms of such a theory is capable of removing the singularities.

The last two sessions went briefly into problems of nuclear structure and nuclear reactions, and here one is on much firmer ground, since, in spite of uncertainty about the basic laws, a great many features of nuclear theory are qualitatively well understood.

In the session on the solid state, I was impressed with the quality and extent of the Japanese work on slip lines and their examination with the electron microscope. This is fitting, since the quantitative study of slip lines started in Japan with Yamagouchi. At the conference and at the additional symposia, first-class work was described by Fujiwara in Hiroshima, by Takamura in Kyoto and by T. Suzuki and Fujita in Sendai. One of the most interesting discoveries during the past few years in this field is the fact that marked work-hardening of metal crystals occurs only when they slip on more than one set of planes. In Great Britain we became aware of this owing to experimental work carried out here and in Germany since 1949; but we now find that the main facts were established by Fujiwara in Hiroshima during the War and published in the Japanese language.

There is also much interesting work in Japan on the theory of dislocations. Here I think that one can still claim that the first steps were taken in Europe and America; but the Japanese physicists, in spite of an almost complete absence of personal contact with other countries, have acquired a detailed knowledge and appreciation of the published literature and are now making important contributions of their own. I was particularly interested in H. Suzuki's modification of the model of the Frank-Read source, which shows how the plane of slip could shift by one lattice plane for each dislocation produced, especially in view of the convincing experimental evidence from several centres in Japan that this actually occurs. A slip line within a crystal may thus have a thickness equal to the slip distance.

In an article of this length it is impossible to describe more than a few of the subjects discussed. The study of *F*-centres arouses great interest in Japan; and I vividly remember an informal session in which Prof. Seitz expounded for hour after hour all that he knew on this subject to a large and eager group that simply could not have enough. In fact, this was the impression that we all had—of large numbers of young workers, of great eagerness and talent. There is no doubt that fundamental research greatly attracts the youth of Japan, and that, in spite of very inadequate financial rewards, research is what they want to do.

Two other aspects of the conference deserve mention. One is the great amount of space devoted to it by the Japanese press and the popular interest that it excited. Every day the newspapers carried long articles about the proceedings of the conference, photographs of the delegates and accounts of their views on many subjects, scientific and otherwise. Reporters accompanied us to garden parties, to receptions and on excursions to the temples and gardens of Japan, and often became our very good friends, telling us what we wanted to know of the life of the country and showing us things that we might not otherwise have seen. To the question that we were always asked, what are the most important results of the conference, we could only answer that through it the Japanese physicists and those of the rest of the world have got to know each other, to appreciate each other's work, and to establish mutually stimulating contacts. This was certainly true, and made the conference well worth while.

The other point is the warmth and the charm of the hospitality that was showered upon us. Everything that could be done was done to make our stay enjoyable and comfortable, to show us the best of the old Japan and of the new Japan. At each city the leading citizens came forward to welcome us, flowers and gifts were pressed upon us, cars and interpreters put at our disposal. I expect that both sides learned much from the customs of the other. I remember how, at a farewell dinner, after which the Western delegates had spoken at some length, Prof. Tomonaga referred to the good and the bad that Japan had taken from the West, including that bad Western custom, the after-dinner speech. The Japanese custom is to give a few words of welcome before the guests sit down to dinner and no afterwards. On the occasions during our stay when this was done, with the elegant dishes of the country spread out before us, there was certainly no temptation to speak too long. Perhaps this is one of the customs that we might learn from Japan.

N. F. MOTT