Experimental Results

The first section of the main session was devoted primarily to the presentation of experimental results, with some papers discussing their theoretical interpretation. Very many of the papers presented by the Soviet physicists described work that has been done with the 680-MeV. synchrocyclotron; with the nucleon and π-meson beams from this machine, they have been able to extend to higher energies knowledge of the cross-sections for the elementary scattering processes.

While for energies up to 300 MeV. most of the possible elementary experiments on scattering of nucleons have now been made, so that a phenomenological interpretation in terms of phase-shift is becoming clear, the more complex situation at energies up to 600 MeV., with the competition of the inelastic meson-producing events, is still far from being completely understood. Soviet physicists described preliminary work on the polarization of scattered nucleons at these energies, which will give some of the extra clues needed. Neutron–neutron scattering has been investigated with the help of deuterium targets, and the evidence supports the belief that the scattering should be the same as for protons on protons, as is already well known at lower energies. The scattering of π-mesons has now been explored up to 300 MeV., but the new data are insufficient to yield any fresh information about the interaction of mesons and nucleons.

Other sessions were devoted to photonuclear reactions, and to new particles. In the latter, A. I. Alikhanyan produced evidence for the existence of a new meson; in an analysis of the masses of cosmic-ray particles he found, in addition to groups corresponding to μ-, π- and K-mesons, a clearly separated group (twelve events) of particles with a mass of 560 ± 120 electron masses.

In addition to the papers by Soviet physicists, there were a number of papers presented by the visitors, especially those from the United States, surveying recent and current work on the same topics in other institutes.

Field Theory and Related Matters

There were four sessions devoted to field theory and other technical theoretical matters. These naturally did not command so large an audience as those in the main section, but the sustained interest of a large number of young Soviet physicists was remarkable. Several of the papers presented related to the question of the utility of field theory; a subject which also overflowed into the main section. One extreme point of view, strongly advocated by L. D. Landau, I. Ya. Pomeranchuk and others, contends that the theory is nonsense because a logically consistent discussion of the solution of the equations appears to lead to the absurd conclusion that there is no interaction at all between different fields. Against this it is contended, not only that this conclusion has not been proved rigorously, but also that, in meson physics, the field theoretical ideas have proved to be qualitatively correct in many respects, and should be retained as a guide until a better theory can be formulated.

Among the applications of field theory there was discussion about the formulation and use of 'dispersion relations' for the scattering of nucleons; at present there is no simple way of using these, analogous to their successful employment in the discussion of meson scattering.

The discussions at this conference, and the close personal contacts made at many levels, were very encouraging for future international collaboration in scientific work. There appears to be reason to hope that they will be followed, not only by further conferences in which East and West will co-operate, but also by individual visits and by correspondence on matters of common interest.

T. G. Pickavance
T. H. R. Skyrme

GENEVA CONFERENCE

THE symposium on High Energy Accelerators and Pion Physics, organized by the European Organization for Nuclear Research (C.E.R.N.), was held in the Institute of Physics of the University of Geneva during June 11–23. Although some of the participants had attended the Moscow Conference, and a few of the papers were repeated, the great majority of the papers were heard for the first time. There were representatives of all the twelve member States of the Organization, about fifty each from the United States and the U.S.S.R., and others from Australia, Canada, Czechoslovakia, India, Spain and the United Nations Educational, Scientific and Cultural Organization.

High-Energy Accelerators

The first week was devoted to high-energy accelerator problems, with the emphasis on new ideas rather than recitations of lists of parameters. Authors of main papers, of 30 min. duration, had been invited to submit texts well in advance for reproduction and distribution by the Organization, and nearly all of them had co-operated. This procedure lends itself well to accelerators, development of which takes years of effort by large teams, though less well to experiments in physics. Many authors had taken the opportunity to write up their work in considerable detail and at greater length than could be accommodated in a half-hour talk. The conference 'preprints' were therefore very useful documents, and greatly aided discussion after the formal presentation of papers. Ample time was left for informal discussion, and there were no parallel sessions.

Main papers were presented by the Middle West (MURA) Group from the United States (D. W. Kerst, K. R. Symon, L. W. Jones) on the new fixed-field alternating gradient machines (FFAG). The object of the MURA project is to accelerate protons to energies of 15 GeV. or more, in a ring-shaped magnet energized by direct current and accommodating a large range of particle momenta in a small range of orbit radii. A disadvantage of normal synchrotrons, whether of constant gradient or alternating gradient type, is that the rate of repetition is limited to a low value by the problem of cycling the magnetic field; this difficulty is absent from machines of fixed-field type, and much higher intensities are hoped for. However, it is necessary to introduce azimuthal variations of magnetic field, and there are severe fundamental difficulties in establishing a stable system of particle dynamics. High-intensity operation also poses serious radio-frequency and phase-stability problems. All these matters were

discussed, together with a proposal by the MURA group to combine the beams of two such accelerators so that protons travel in opposite directions before collision. The energy liberated in the centre of mass system of co-ordinates would then be 30 GeV., for two 15-GeV. accelerators, and this would correspond, in the usual system where the target proton is at rest, to a bombarding energy of about 600 GeV. However, very high beam intensities would be needed for a useful yield of collisions.

Colliding-beam systems have been discussed for many years, but efforts are now beginning to be made to discover means of making them more plausible. There was much discussion of 'storage rings', for example, by W. M. Brobeck (Berkeley) and G. K. O'Neill (Princeton). A pair of these could produce colliding beams in a common sector, the rings being fed alternately by a single high-energy accelerator. Some of the informal discussion entered the realms of fantasy, but it was very stimulating.

Fixed-field alternating gradient systems may also be applied to cyclotrons, and a main paper by the Harwell group (T. G. Pickavance) discussed studies of machines of that type for high-intensity operation at about 3 GeV.

Three important Russian papers were presented on 'new ideas'. A. Naumov reported the work of Budker on relativistic stabilized electron beams (previously reported in Moscow). V. I. Veksler, in a most interesting contribution, speculated upon the possibility of accelerating particles in dense bunches using the field between a bunch and another group of charges, a plasma, or an electromagnetic wave. Such methods Veksler called 'coherent', because the force on a single particle would be proportional to the number of particles in the bunch. One possibility would be to exploit an 'inverse Cerenkov effect', according to which a medium, travelling rapidly past a charged particle, imparts energy to the particle. Ya. B. Fainberg discussed a system in which a plasma could be made to act as a wave-guide, particles being accelerated by an applied radio-frequency field. Phase and radial stability could be achieved and power losses would be less than those experienced with ordinary metal waveguides.

The remaining accelerator sessions dealt mainly with problems of existing machines or machines under construction. Papers on phase transition, radio-frequency acceleration injection, and extraction were presented by members of the Brookhaven, CERN and Russian groups concerned with the large alternating-gradient proton synchrotrons, and on magnet problems by the same groups and by M. Bruck (Saclay), J. M. Blamey (Canberra) and D. W. Kerst (MURA). There was a session on the important topic of non-linear betatron oscillations, in which main papers were read by R. Hagedorn (CERN), E. D. Courant (Brookhaven), A. A. Kolomenski (U.S.S.R.) and K. R. Symon (MURA), and another on linear accelerators with contributions from Brookhaven, Harwell, Kharkhov, Berkeley and Stanford. L. W. Smith (Brookhaven) and E. J. Lofgren (Berkeley) reviewed the operational problems of the 3-GeV. cosmotron and the 6-GeV. bevatron, respectively. These two great machines have now become organized facilities for research; the scale of organization required impressed everyone at the conference. For example, the bevatron requires the full-time services of nearly eighty people, from graduate physicists and engineers to craftsmen and technical assistants, not counting the research workers engaged in experiments. A degree of organization, at one time considered foreign to fundamental research, has therefore to be applied to the research programme; this is a difficult problem.

The accelerator sessions were most lively and successful, and it was noteworthy that the informal discussion was maintained at an exceedingly high standard to the end. Accelerator studies have developed into a branch of learning in their own right, and the conference showed that many laboratories in many countries are making vital contributions to this rapidly advancing field.

Developments in Technique

The first one and a half days of the second week were devoted to discussions of developments in technique. An introductory talk by D. A. Glaser, of the University of Michigan, on bubble chambers was followed by seven other papers on the subject from laboratories in France, Italy, the United States and the U.S.S.R. Attempts to improve the cycling time of cloud chambers were discussed by British and American groups.

In a review of recent advances in millimicrosecond-counting techniques, O. Chamberlain (University o California) mentioned the production of an experimental transmission type of photomultiplier by Sternglass and Wacktel, of the Westinghouse Research Laboratories. In one design the multiplying electrodes consist of gold foil 20 A. thick followed by a layer of potassium chloride 450 A. thick. The tubes require a few kilovolts per stage, and with seven stages of multiplication yield pulse-rise times of less than 1 millimicrosecond, but at the present stage of development they suffer from severe fatiguing troubles. A new R.C.A. tube (type number 6810) is, however, commercially available and this has the advantage of an output of 0·3 amp., so that for many applications it is possible to dispense with further amplification. By limiting the area of the photocathode it is possible to get rise-times as short as 1·5 mμsec.

One afternoon of the conference was devoted to the presentation and discussion of experimental results. It is perhaps a significant pointer to the future that pride of place was given to a session entitled "Antiproton Physics". E. Segrè gave a review of the antiproton work at Berkeley. For the time being, antiprotons have been produced only by proton bombardment of copper targets in the bevatron. From a study of stars produced by the interaction of antinucleons with matter, it has been determined that some stars show a visible energy release greater than Mc^2, which is proof that the antiproton is annihilated with a nucleon. It is not yet known whether the mechanism of production is a nucleon–nucleon collision producing an antinucleon–nucleon pair, or whether an intermediate step involving the production of a π-meson is required.

Interaction cross-sections in beryllium and in copper have been measured and found to be about twice the cross-section for protons. A possible explanation of this unexpected result has been given by Duerr and Teller (*Phys. Rev.*, **101**, 494; 1956).

Another striking event of the conference was an announcement by Prof. W. Pauli of news from the United States that the well-known inverse beta decay experiment of Cowan and Reynes had yielded a positive result, compatible with a cross-section of about 6×10^{-44} cm.^{2}. Evidence for the existence of the neutrino has thus been established.

Meson Physics

Most of the remaining sessions were devoted to meson physics. This was a deliberate policy on the part of the organizers of the conference, who had in mind the experiments that will be carried out on the C.E.R.N. synchrocyclotron (due for completion in 1957). The continued great interest in this important field was illustrated by the large number of interesting papers presented from many laboratories. It must suffice to summarize the proceedings by saying that many experiments gave supporting evidence for the existence of an isobaric state of the pion–nucleon system and of such a state in the charged-pion production process.

An elegant experiment outside the field of meson physics was reported by R. Hofstadter, on the structure and size of the proton. This experiment was carried out by measuring the angular distribution and differential cross-section for the scattering of high-energy electrons by protons. At large angles and high energies, the cross-section for scattering deviates from that expected for a point proton by about a factor of nine. The results fix the root mean square radius of the proton at $0{\cdot}77 \pm 0{\cdot}10 \times 10^{-13}$ cm. for each of the charge and momentum distributions.

There were visits to the CERN site at Meyrin, near the French frontier. It was most encouraging to see the great progress made on the construction of the elaborate foundations and ring building of the 25-GeV. machine. Construction of the 600-MeV. synchrocyclotron appeared to be well advanced. The whole conference was well organized and was a good augury for the continued vitality of this absorbing field of study.

T. G. Pickavance
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SYNTHETIC DETERGENTS AND THE TREATMENT OF WATER AND SEWAGE

SINCE 1949 there has been something like a threefold increase in the sales of synthetic detergent mixtures in Britain, the majority of which contain as their most important constituent anionic surface-active agents of the alkyl aryl sulphonate type. Although these substances are used to some extent in industry, the big expansion in their sale during the past ten years has been for domestic purposes. Thus most of the synthetic detergents now used in Britain are discharged by the housewife to the sewers of local authorities and, except in some coastal towns, eventually pass to a sewage-disposal works.

Domestic sewage is normally treated by sedimentation and biological purification, and although the methods used may appear to the uninitiated as somewhat crude and primitive, they are in fact extremely efficient and capable of effecting a high degree of purification at a remarkably small cost. They are, however, rather easily upset by the presence in the sewage of certain types of substances, particularly those which interfere with microbiological processes, this being the main reason why it is often difficult to treat sewage in an industrial district where large quantities of trade effluent are discharged to the sewers. During the past few years there has been a growing feeling that household synthetic detergents are among the substances which cause difficulties at sewage works. Moreover, it is known that part of the surface-active agent they contain often passes through a treatment plant and so is discharged with the effluent to a river. It is common knowledge that during the past few years there has been a marked increase in the extent to which foam is formed on polluted rivers, particularly at places where they pass over weirs, and this again is commonly attributed to the presence of the surface-active materials in the water. In some parts of Britain rivers to which sewage effluents have been discharged have to be used as a source of raw water for domestic supply, and there has therefore been some anxiety as to whether surface-active agents may persist throughout a water-treatment plant and so be present in the supply distributed to a town, particularly since this is known to have occurred during exceptionally dry weather in at least one place in the United States[1]. For these reasons the Minister of Housing and Local Government some time ago set up a committee under the chairmanship of Sir Harry Jephcott to study the subject; its report has just been published[2]. A few weeks ago also the Association of American Soap and Glycerine Producers (who make synthetic detergents), through a report prepared by F. J. Coughlin, chairman of the Association's Technical Advisory Sub-Committee on Research, has made available the results of its own observations on the position in the United States[3].

The report of the American Association gives the impression either that the effects of detergents are not so marked in the United States as they are in Great Britain, or that if they are the Association has not fully appreciated the difficulties that have been caused. It is certain that at many sewage works in Britain, and especially at those using the activated-sludge process, frothing has increased during the past few years to a point at which operation of the plant is made very difficult, and in some cases dangerous, and that this frothing is due to the presence of surface-active constituents of synthetic detergents in the sewage; indeed, the British report includes two photographs of frothing at sewage works, at one of which the layer of foam appears to be several feet thick. The American Association, while agreeing that frothing has increased in the United States, does not appear to accept that detergents are the cause of it. It says also that frothing on the surface of aeration tanks and activated-sludge plants can be stopped by increasing the concentration of activated sludge in the mixture aerated. This was not found to be so in Britain, where experiments were made, at the suggestion of Sir Harry Jephcott's Committee, at several sewage works without any marked success. An important point of principle is, in any event, involved here; the processes used at sewage works have been evolved from experience and experiments over many years and the conditions at any particular plant are chosen to bring about the most effective purification of the sewage. It is very rarely that they can be drastically changed merely to prevent some