

fundamental work of the Dutch and British laboratories in this intricate research is important. Two papers reported developments in the use of air as a commercial separating medium in desert country.

The largest group dealt with the froth flotation process, at all levels from that of the fundamental worker in surface chemistry to that of the specific problems handled in exploiting plants. The physics of frothing, aeration and attachment of a hydrophobic particle to an air-bubble in water were well represented. The effects of minute traces of soluble ions on the specific development of hydrophilic and hydrophobic surfaces were also considered. Other papers dealt with ion-migration study involving radioactive isotopes and the application of electrochemical methods to flotation research.

The present position of magnetic, electrostatic and photometric techniques was discussed in three papers. A striking symptom of change is the fact that only one paper dealt with the chemistry of cyanidation, although two others discussed plant practice in gold extraction. If mineral dressing had been of sufficient importance twenty years ago to bring together an international gathering of this calibre, the cyanide process might have dominated the scene. Even on the Rand, where the technology was first established, the main interest is now in the flotation of uranium from cyanide tailings—a process still on the secret list and therefore not presented at this symposium. Among the papers dealing with commercial practice was one on lead-zinc concentration, one on a gold-copper-zinc-pyrite complex, one on the design of small plants and one on the milling of asbestos.

The symposium brought a large gathering of scientific workers and engineers from all over the world, and discussion and interchange of views were sustained at a high level throughout the three days of the meeting. Appropriately to the occasion which had brought so distinguished a gathering of experts to Britain, the partly completed sections of the reconstructed Bessemer Laboratory of the Royal School of Mines were open. The 1910 layout, which contained what may have been the earliest pilot plant for industrial teaching and research, is being modernized to meet the need for specialized training of students and to provide further facilities in Britain for research in ore concentration, one development of which is the new degree course of the University of London in mineral dressing. E. J. PRYOR

## NEW RESEARCH TECHNIQUES IN PHYSICS

### SYMPOSIUM IN BRAZIL

A SYMPOSIUM on "New Research Techniques in Physics" was jointly organized by the Academia Brasileira de Ciências and the Centro de Cooperación Científica para América Latina (Unesco) and was held in Rio de Janeiro during July 15-22 and in São Paulo during July 24-29. The meeting had a double purpose: to provide for Latin American physicists an opportunity of discussing their problems, as part of a more general programme of the activity of Unesco in Latin America, and to stimulate and help the development of modern research in Brazil, by inviting a number of distinguished foreign scientific workers. The meeting was sponsored by the Conselho

Nacional de Pesquisas (National Research Council; president, Admiral Alvaro Alberto), and, in São Paulo, by the University of São Paulo.

The number of foreign participants was very encouraging, and Latin American physicists came from Argentina, Bolivia and Mexico, of whom the strongest group was that from Mexico, giving seven papers out of a total of sixty-seven. Prof. M. S. Vallarta (Mexico) reported on an injection mechanism of charged particles due to the variable magnetic field of sunspots. He pointed out that protons in a sunspot could be accelerated up to  $6 \times 10^9$  eV., while electrons, in the same field, would lose most of their energy by electromagnetic radiation.

I. Escobar (Bolivia) reported on work he had done at Echo Lake on the east-west asymmetry of positive and negative mesons. He expects to be able very soon to continue this work on the geomagnetic equator, at the high-altitude station at Chacaltaya (5,300 m.) which will be operated jointly by the Universidad Mayor de San Andrés (La Paz) and by Dr. C. Lattes, Centro Brasileiro de Pesquisas Físicas. Two papers were read by Argentine physicists: K. Fränzl has constructed in Buenos Aires an electronic multiplier, which gives 1,000 multiplications per second with a precision of about 1 per cent; and R. Gans showed how he has been able to solve Hallén's integral equation for the current in a linear antenna in the neighbourhood of resonance frequencies, obtaining a remarkable agreement with experiments.

Prof. J. Costa Ribeiro (University of Brazil) gave a detailed report on a new phenomenon which he has called the thermodielectric effect. He has found that the transition of many dielectric substances from the solid to the liquid state is accompanied by a weak electric current. In the case of naphthalene, the effect is of the order of one electron charge liberated for  $10^{10}$  molecules passing from one phase to the other. Prof. Ribeiro pointed out that the detailed mechanism of the phenomenon is, however, not clear and that it has not yet been possible to establish to what degree the effect is characteristic of a pure substance and how it becomes, eventually, influenced by adding foreign ions.

Several papers dealt with work in Prof. B. Gross's laboratory at the Instituto Nacional de Tecnología. Prof. Gross reported briefly on the behaviour of an electret under variation of temperature and, in another communication, dealt with the work which leads him, alternately, to consider the transformations which connect creep and relaxation of elastic substances and admittance and impedance of electric circuits. He also dealt with electric networks connected either in parallel or series. H. Barbosa (University of São Paulo) reported on certain semiconductors which he has found to be very sensitive to elastic deformations. Prof. R. M. Fuoss (Yale University), who spoke in Portuguese, gave an account of work on polyelectrolytes, in which large polymer molecules carry several charged atoms. Chain molecules are known to influence the viscosity of a solution and, in the case of polyelectrolytes, electrostatic forces, which modify this influence, have to be considered.

A considerable fraction of the symposium was devoted to new apparatus. In the inaugural session H. L. Anderson reported on the new 170-in. synchrocyclotron at Chicago, and D. W. Kerst (University of Illinois) described the three betatrons which are now in operation in Urbana, reaching X-ray energies

of 22, 80 and 320 MeV. M. D. Sousa Santos (University of São Paulo) reported on the betatron which he has put into operation in São Paulo and which furnishes X-rays up to 29 MeV.; it is the first instrument of that power which has been set up in Latin America. A series of communications of his collaborators dealt with results which have been obtained so far with the São Paulo betatron, using the excitation function of  $^{63}\text{Cu}(\gamma, n)^{62}\text{Cu}$  in order to test the energy spectrum and the angular distribution of the X-ray beam.

R. G. Herb (University of Wisconsin), F. Alba (University of Mexico) and O. Sala (University of São Paulo) discussed electrostatic generators. In Mexico a 2-MeV. Van de Graaff generator, made in the United States, has been put into operation, while the São Paulo generator, designed to give 3.5 MeV., is still under construction. J. Marshall (University of Chicago) described his Čerenkov counter for cosmic rays, and this was followed by a number of papers dealing with experimental observations noted during the construction of Geiger-Müller counters. S. de Benedetti (Carnegie Institute of Technology) described a coincidence circuit which, in connexion with scintillation counters, permits him to obtain a time resolution of  $10^{-9}$  sec., sufficient to determine the time of flight of a gamma-ray quantum over a distance of a few centimetres. P. Ribeiro de Arruda (University of São Paulo) showed a diffusion cloud chamber operating at a constant temperature gradient.

G. P. S. Occhialini (Brussels) replaced his report on nuclear emulsions by a more detailed seminar in that field. The results which were communicated at the symposium showed clearly four different lines along which modern physics is progressing, namely, modern quantum electrodynamics, nuclear forces, mesons and high-energy phenomena.

Dealing with the first of these, though modern quantum electrodynamics was not represented at the meeting, it intervened in the report of M. Deutsch (Massachusetts Institute of Technology) on positronium. The transfer of momentum between an electron and positron by means of virtual annihilation was studied many years ago by Bhabha, and its influence on the hyperfine structure of the electron-positron system has been discussed by J. Pirenne. But when Dr. Deutsch recently succeeded in determining this hyperfine structure by registering the annihilation radiation of positronium-levels, he not only verified directly the existence of these forces, but he was also able to measure the radiative corrections for them. Dr. de Benedetti has been able to measure the life-time of positrons in metals and has found the surprising result that this life-time does not depend on the particular metal used. He has also been able to register three photon disintegrations of positrons, a phenomenon which, in agreement with theory, is about 370 times less frequent than two photons disintegrating. We can already expect that a new chemistry will be found, one in which hydrogen becomes substituted by positronium, though the substances to be studied will have an extremely short life-time.

Nuclear forces were dealt with in Prof. E. P. Wigner's report. Recent work in Princeton University has led him to the conclusion that the strong spin-orbit coupling, characteristic for the nuclear shell model, can be understood, at least by sign and order of magnitude, as a result of the action of central and tensor forces. A similar result has been found by R.

Oehme (Instituto de Física Teórica, São Paulo), who considered the motion of a nucleon in the pseudo-scalar meson field of a core. Prof. Herb described the precautions he has had to take in order to make sure that at 4.2 MeV. a small amount of proton scattering appears in the proton-proton collision. Prof. Kerst mentioned in his report the possibility of studying the photodisintegration of deuterons in the energy-range 150-300 MeV.

Important progress has been made in the study of the meson field. A target, beryllium, aluminium or liquid hydrogen, placed in the proton beam of the Chicago synchrocyclotron, has been instrumental in obtaining  $\pi$ -mesons from proton-proton collisions up to 220 MeV. Both Dr. Anderson and Mrs. L. W. Marshall reported on work done with meson beams. Cross-sections were determined for the processes:

$$\begin{aligned} \pi^+ + p &\rightarrow \pi^+ + p, \\ \pi^- + p &\rightarrow \pi^0 + n, \\ \text{and } \pi^- + p &\rightarrow \pi^- + p. \end{aligned}$$

Comparison between these cross-sections was possible at 135 MeV. The elastic scattering was found to be about isotropic, while the charge exchange leads to a marked backward scattering. The cross-section of the first process has been found to be several times larger than that of the last. The observed values agree well with a charge-symmetric interaction which makes the total isotopic spin an integral of motion.

Prof. Kerst's large betatron gives photoproduction of  $\pi$ -mesons, a subject which is under investigation. A search has been made to detect V-particles, so far without result; there is certainly less than one V-particle per 2,500 photomesons at 300 MeV. The difficulties of meson theory were emphasized by J. Leite Lopes (Centro Brasileiro de Pesquisas Físicas), who reported on an attempt made by himself and R. P. Feynmann with the aim of accounting for the deuteron structure by means of pseudoscalar mesons. An interesting point was brought forward by G. Fialho (Centro Brasileiro de Pesquisas Físicas), who, following the suggestion of Prof. G. T'iomno, showed that the, eventually anomalous, magnetic moment of the  $\mu$ -meson accounts for most of the weak  $\gamma$ -radiation which accompanies the  $\pi \rightarrow \mu$  decay.

Finally, high-energy phenomena, in particular the multiple production of mesons, were discussed in two papers. G. Molière (Centro Brasileiro de Pesquisas Físicas) reported on work he had done in Göttingen together with J. Budini—a phenomenological theory of the development of a nucleon cascade. G. Wataghin (University of Turin), outlining what has grown out of the pioneering work he had done during fifteen years in São Paulo, discussed a field theory with non-localized interaction, which promises to account for multiple meson production.

It is perhaps surprising that no new meson was reported during the symposium, though almost a month had passed since a previous meeting of nuclear physicists in Copenhagen.

Among the many other interesting papers, mention must be made of a report by Dr. D. Bohm (University of São Paulo) on his attempt to give a causal interpretation to the formalism of quantum mechanics.

The symposium was judged by all concerned to have been very successful, and not the least credit for this is due to Dr. A. Moses, president of the Brazilian Academy, and to Prof. J. Leite Lopes, who devoted several months to the work of organizing it.