MEDIUM-ENERGY NUCLEAR PHYSICS

CONFERENCE AT THE UNIVERSITY OF PITTSBURGH

DURING June last, the University of Pittsburgh sponsored a second conference on medium-energy nuclear physics similar to that held in 1952. There were five sessions of invited papers inter-mingled with discussions. The first dealt with beta-decay, the second with nuclear forces and capture gamma-rays, the third with photon-induced reactions, the fourth with inelastic neutron scattering and nuclear energy-levels, and the final one with neutron-induced reactions.

The first paper, by L. Langer (Indiana University), discussed the evidence for a unique beta-interaction which can explain all known features of beta-decay. This includes the shape of the allowed and forbidden spectra, selection rules, the radium-E spectrum, and angular correlations between the emitted electron and the recoil nucleus. It seems likely that a linear combination of scalar, tensor, and perhaps some pseudoscalar can account for all known effects. In the second paper, M. E. Rose (Oak Ridge National Laboratory) indicated that even theoretically there are deviations from straight-line Kurie plots to be expected other than those due to Fierz interference. He suggested an experiment, the angular correlation in the $^{14}O \rightarrow {}^{14}N^*$ decay, which would definitely fix the nature of the Fermi-type interaction. In the third paper of the session, H. Primakoff (Washington University in St. Louis) reviewed the experimental evidence of Fulbright and McCarthy, and of Ingram and Reynolds for the existence and half-life of nuclei undergoing double beta-decay. The observed half-lives of zirconium-96 (10^{16} yr.) and of tellurium-120 (10^{21} yr.) make the effect difficult to detect. The theoretical estimates of such half-lives depend on the assumption of the existence of an anti-neutrino distinct from the neutrino or on the opposite assumption. The theoretical estimate is also difficult to make, but it appears that the no anti-neutrino hypothesis fits better. The decay of the μ-meson may be able to clarify the question.

The second session was opened by I. Talmi (Princeton University), who showed how the empirical rule that in even–even nuclei the spins and parities of excited states are either both odd or both even can be understood. It is necessary to use the fact that the potential is short-range, but then the result follows in both the Russell-Saunders and j–j coupling limits. The second paper was a review of the Butler theory of stripping reactions by E. Gerjuoy (University of Pittsburgh). This theory has been of great service in discovering the spin and parity of many nuclear-levels. It is not, however, in complete agreement with observed angular distributions. Arbitrariness in fitting the distribution could be reduced by comparing experimental and theoretical absolute differential cross-sections. However, the method of making allowance for Coulomb interactions is not at all clear. In the third paper, E. B. Paul (Chalk River Laboratory) spoke of his work on gamma-rays following proton capture. This work was done with the Chalk River electrostatic accelerator. The observed intensities of various gamma-rays of the same multiple order do not seem to accord with present theoretical expectations. The final paper of the session was a report by G. Bartholomew (Chalk River Laboratory) on work by B. B. Kinsey

and himself with neutron captive gamma-rays. In particular, he discussed the great intensity of electric dipole radiation when the states were such as to permit it. Strong transitions to states other than the ground-state were found, where the information was sufficient, to be electric dipole.

The third session was opened by V. Telegdi (University of Chicago). He gave an account of the operation of isotopic spin selection rules in reactions induced by photons. The threshold energy of certain reactions, notably (γ,α) reactions, shows the operation of the conservation of total isotopic spin law. His experiments have been carried out with photographic plates. The other paper of this session was given by L. Katz (University of Saskatchewan). He reported on his work on reactions induced by photons from a betatron. In particular, he has studied neutron production, and has obtained indications of nuclear-levels by breaks in the yield-curve of neutrons as a function of photon energy.

The first three papers of the fourth session were devoted to inelastic neutron scattering. J. Beyster (Los Alamos Scientific Laboratory) described the spherical shell method for measuring inelastic neutron cross-sections. H. A. Bethe (Cornell University) discussed the interpretation of such experiments at energies where elastic scattering is large and nearly isotropic. The difficulty lies in the increased path-length in the shell due to elastic scattering. Methods for allowing for this which give values for inelastic scattering independent of experimental geometry were described. The resulting cross-sections vary as the geometrical cross-section except in the cases of the so-called magic nuclei, where they are smaller. T. Bonner (Rice Institute) described sphere measurements at higher neutron energies where the elastic scattering corrections are unimportant. The cross-sections turn out to be in good agreement with the geometrical cross-section except for the magic nuclei lead and bismuth, which are 10 per cent low. At low energy (~ 3 MeV.) the cross-sections are less than the geometrical. R. Hellens (Westinghouse Electric Corp.) described some neutron scattering experiments on iron using photographic plates. F. Ajzenberg (Massachusetts Institute of Technology) closed the session with a comprehensive review of the energy-levels of light nuclei with especial emphasis on charge symmetry and charge independence of nuclear forces.

The last session was opened by H. Feshbach (Massachusetts Institute of Technology). He showed how the concept of the nuclear radius is at present ambiguous. Electron scattering, isotope shift, and μ-meson decay all measure the average electrostatic potential in the nucleus and all give results corresponding to a nuclear radius of $1 \cdot 2 \times 10^{-13} A^{1/3}$ cm. The binding energies of mirror nuclei, also affected by Coulomb forces, give $1 \cdot 45 \times 10^{-13} A^{1/3}$ cm. At present this cannot be reconciled. Next H. Barschall (University of Wisconsin) described the results of his work on the scattering of neutrons of heavy elements. The dependence of the cross-section for scattering on the incident energy and on the mass number has been determined over a wide range of these variables. This variation can be interpreted, as V. F. Weisskopf (Massachusetts Institute of Technology) explained in the next paper, on the 'cloudy crystal ball' model of

the nucleus. The nucleus is represented by a potential with an imaginary part which represents absorption of the neutron. Adjustment of the depth, the radius (which is assumed to vary as $A^{1/3}$) and the absorption enables a very good fit to be obtained over the entire range of energy and mass. It may be possible to interpret the absorption in terms of the formation of a compound nucleus. The last paper was by C. Goodman (Massachusetts Institute of Technology), who presented some evidence of nuclear excitation by the electrostatic field of an incident proton.

PHILIP STEHLE

AMERICAN AID FOR SCIENTIFIC AND INDUSTRIAL RESEARCH IN GREAT BRITAIN

FURTHER details of the proposed expenditure on advisory service, research and on education and training of the Counterpart Funds derived from United States Economic Aid under the Mutual Security Act of 1952, originally outlined in Cmd. 8776 of February 25, 1953, are given in a White Paper dated July 1953 (Programme of Expenditure of Counterpart Funds derived from United States Economic Aid. Cmd. 8918. Pp. 8. H.M.S.O. 4d. net). Under "Advisory Service", £25,000 goes to the Department of Scientific and Industrial Research for the development of advisory services in industrial engineering, and in the use of measurement techniques developed in the National Physical Laboratory, and a further £125,000 for assistance to research associations (in conjunction with trade associations where suitable) for the development or initiation of advisory services. A number of trade and employers' associations will receive grants totalling £72,000 in all to enable them to employ consultants on such subjects as cost accounting, factory lay-out and organization and the deployment of labour. The Ministry of Works receives £20,000 for the development of the Building Advisory Service, and the Ministry of Labour and National Service £15,000 for assistance to voluntary organizations developing advisory services to industry in the field of training. Agricultural departments will receive £116,500 for the extension or initiation of specific advisory services, and the British Institute of Management £35,000 for research and the preparation and provision of information of management subjects of importance to productivity and for the extension of the Institute's information and research departments.

Of £589,500 provisionally allocated for research, £210,000 goes to a programme of economic research based in part on proposals put forward by universities and research organizations. It includes £42,000 for studies of general factors affecting productivity and the adoption of innovations ; £100,000 for studies in monopoly, competition and restrictive practices, including studies in the structure of selected industries ; £25,000 for studies in the growth of capital and the finance of industry ; £8,000 for studies of economic problems affecting labour recruitment and mobility ; £11,000 for studies in economic problems of transport and £19,000 for studies in the statistical measurement of production. The programme of research in production economics, for which £75,000 is allocated, will be carried out under the ægis of the Department of Scientific and Industrial Research by research associations and other bodies. It will include

studies of the innovation and development of new ideas ; of the flow of scientific and technical information to industry and its relation to innovation and industrial efficiency ; of the economics of re-equipment ; and of the measurement of productivity and the causes of variation of industrial efficiency.

The programme of social research, for which £190,000 is allocated, will be planned and co-ordinated by the two Committees on Human Relations in Industry and Industrial Efficiency recently set up by the Lord President of the Council. It includes £20,000 for studies of the influence of equipment design and working conditions on the efficiency of operators ; £15,000 for studies of factors affecting the efficient utilization of industrial engineering techniques ; £30,000 for studies of factors influencing the effectiveness of incentive payment schemes ; and £40,000 for studies of those restricting and facilitating the introduction of new production techniques and methods in industry ; £30,000 for studies of the characteristics of management organizations influencing productivity ; £10,000 for studies of factors facilitating the efficient utilization of university graduates in industry ; and £25,000 for studies of promotion and training in industry. The allocation of £114,500 for research in agricultural subjects includes £8,000 each for studies in land ownership and in land economics ; £25,000 for a survey of prevalence, etc., of livestock diseases, and £22,500 for studies of egg- and table-poultry production.

Of the £519,000 provisionally allocated for education and training, £290,000 is for the endowment of three university chairs or readerships in engineering and related subjects. It is hoped that one in heavy electrical engineering and another in production engineering will be at the Imperial College of Science and Technology, London. The £130,000 for technical education is for the creation of teaching posts in industrial engineering and the provision of scholarships in methods of engineering, work study and personnel management. Of £68,000 to agricultural departments, £25,000 is for postgraduate scholarships and a like sum for managerial and special courses for staffs of Co-operatives, £18,000 is for assistance to Scottish crofters, £20,000 is provided towards the development of engineering training facilities at Queen's University, Belfast, and the Belfast College of Technology, and £6,000 to the Department of Scientific and Industrial Research towards technical and management training in the cast iron industry.

The allocation for publicity includes £22,400 for publications, chiefly to the Department of Scientific and Industrial Research for the preparation of technical digests of articles appearing in the technical press, and the preparation of brochures on technical information services ; and to research associations for the preparation of technical publications. An allocation is also being made to the Ministry of Works for the preparation of technical publications giving the results of scientific research and new developments in building. One million pounds has been allocated to the Revolving Loan Fund, £700,000 for loans to industry and £300,000 for loans to agriculture ; advisory committees have been set up for each part of the fund. The types of loan likely to be approved and the conditions which will be attached to them will be announced by the committee for industry, of which Sir John Woods is chairman. Loans to agriculture (of which committee Sir Stanford Cooper is chairman) will be confined in the first instance to