MEDIUM-ENERGY NUCLEAR PHYSICS

CONFERENCE IN PITTSBURGH

THE University of Pittsburgh sponsored a conference on medium-energy nuclear physics which met in Pittsburgh during June 5–7. There were five sessions at which invited papers were given, followed by informal discussion. The first paper was that by G. Scharff-Goldhaber (Brookhaven National Laboratory) under the title "Excited States of Even–Even Nuclei", in which she discussed the energy-level separations and the spins of the excited states of these nuclei. Regularities in these quantities are found when the nucleus is thought of in terms of the shell model, where most nuclear properties are ascribed to the nucleons outside the 'closed shells'. An instructive model showing the excitation energy of the first excited states of nuclei, based on the General Electric isotope chart, was also shown. This paper was followed by one by R. F. Christy (California Institute of Technology) with the title "Selection Rules and Coupling Rules in Light Nuclear Reactions". Dr. Christy proposed that there may be parameters descriptive of nuclei which are almost good quantum numbers for light nuclear reactions. Among these are the isotopic spin T and the partition numbers (p, p', p'') of Wigner. Finally, he mentioned certain reactions which are consistent with Russell–Saunders coupling in nuclei and not with j–j coupling.

At the second session of the conference papers were read by M. E. Rose (Oak Ridge National Laboratory), S. Ridgway (Princeton University) and S. T. Butler (Cornell University). Dr. Rose, speaking on the "Angular Correlation of Nuclear Radiations", said that he was particularly interested in the effect on angular correlations of external perturbations acting on the nucleus. These lead to quenching of the angular correlation. He also described the principles which enable one to deduce the value of the magnetic moment of a nucleus in the state between the emission of two successive gamma-rays. Dr. Ridgway reported on studies of the angular correlation between beta-rays and subsequent gamma-rays. This correlation has been investigated theoretically and depends on the Coulomb correction factor in the spectrum. Experiments have been done on several nuclei, including arsenic-76 and antimony-124. The third speaker, Dr. Butler, outlined the physical principles underlying his calculations of the angular distributions resulting from stripping reactions. A stripping reaction is one in which a deuteron is incident on a nucleus, the nucleus absorbing either the proton or the neutron from the deuteron and making a direct transition to its final state, the other constituent of the deuteron going past. The energy and angular distribution of the unabsorbed particle give information about the state of the absorbed particle in the final nucleus. Dr. Butler then showed how the effect of the Coulomb interaction between the incident proton and the nucleus could be taken into account, both when the neutron and when the proton is absorbed.

H. W. Fulbright (University of Rochester), H. J. Richards (University of Wisconsin) and H. E. Gove (Massachusetts Institute of Technology) were the speakers for the third session of the conference. Discussing "Observations of Angular Distributions in some (d,p) and (d,n) Reactions", Dr. Fulbright said that the study of the beta-decay of certain elements, notably carbon-14, does not lead to complete understanding of the states of the nuclei involved. The theory of Butler, described above, provides an alternative approach to this problem. If the measured angular distribution from a stripping reaction fits one of Butler's theoretical curves, the angular momentum state of the absorbed particle can be inferred. Good enough agreement with such curves has been found to allow the inference, for example, that carbon-14 and nitrogen-14 ground-states have even parity. Dr. Richards, in the next paper, gave a detailed account of the assignments of spins and parities to the energy-levels of boron-10. He showed how the information from many kinds of experiments can be fitted together to yield a consistent assignment, and indicated the sources of some ambiguities. Dr. Gove then presented some results obtained with the cyclotron at the Massachusetts Institute of Technology. These included some energy-levels obtained by the inelastic scattering of protons and by stripping reactions. The angular distributions from stripping reactions were compared with those predicted by Butler and by Tobocman and Friedman. There appears to be a systematic angular displacement towards larger angles than those predicted.

For the fourth session of the conference there were three prepared contributions by, respectively, D. R. Inglis (Argonne National Laboratory), and by A. de-Shalit and E. P. Wigner (both of Princeton University). Dr. Inglis spoke on the subject "Departures from Nuclear Models in the p-Shell". He started by discussing a situation in atomic spectra where two different perturbations, the spin-orbit coupling and exchange effects, cause splitting of the energy-levels. In nuclei this spin-orbit coupling leads to the shell model of the nucleus, while the exchange splitting can be described by the Russell–Saunders coupling. Dr. Inglis then showed how complicated things can become in the intermediate region and discussed the light nuclei in the light of this 'intermediate coupling'. Dr. de-Shalit then pointed out some regularities in the deviations of magnetic moments from the Schmidt lines, in particular the fact that a nucleus with one odd proton has a moment farther from the Schmidt line than the corresponding nucleus with an odd neutron. He proposed an explanation of this in terms of j–j coupling. This paper was followed by that of Prof. Wigner, who started by reminding his audience of several well-known "queer facts" about nuclei, consisting of accurate numerical sequences or equalities. He then proceeded to discuss the possibility that spin-orbit coupling nuclear has as its origin the operation of a tensor force between pairs of nucleons in nucleus. Dr. Feingold has made calculations which give, in light nuclei at least, qualitative agreement between theoretical and experimental values of the magnetic moment and the quadrupole moment. The admixtures of states produced by the tensor force are small, so that Russell–Saunders coupling holds to a good approximation.

The three papers given at the concluding session of the conference were by W. W. Buechner (Massachusetts Institute of Technology), R. S. Bender (University of Pittsburgh) and Katherine Way (National Bureau of Standards). Dr. Buechner described the

apparatus used for both low-energy and high-energy precision determinations of energy-levels, using for the latter the new Van de Graaff generator at the Massachusetts Institute. Results have been obtained for a variety of elements, in many places checking with those obtained elsewhere at low energy, and adding many new ones at high energy. Dr. Bender described the unique high-resolution beam analysing system used with the University of Pittsburgh cyclotron. He then summarized the results so far obtained by its use. These consist of energy-levels obtained from (pp'), (p,α) reactions; many old levels have been found, some with new precision, and many new highly excited levels have been located. Finally, Dr. Way reported a new set of values for the binding energies of the nuclei above lead, and also in the region around neutron number 50 and atomic number 50. These were obtained by considering closed cycles involving alpha-decay and beta-decay. On the basis of the existing experimental data, differences in binding energies at both the neutron and proton 'magic' numbers showed up clearly.

Discussion leaders for the sessions included Dr. Maria Mayer (Argonne National Laboratory), Dr. Maurice Goldhaber (Brookhaven National Laboratory), Dr. S. T. Butler (Cornell), Dr. G. C. Wick (Carnegie Institute of Technology), and Dr. T. Lauritsen (California Institute of Technology).

Philip M. Steele

ISOTOPES IN MEDICINE

THE application of isotopes in medicine is a subject which shows signs of dangerous over-popularization, with the consequent unjustified simplifications of the problem. A recent publication, entitled "Isotopes in Medicine"*, must therefore be very welcome since this series of articles, a number of them reviews, by acknowledged authorities in their respective fields demonstrates clearly the limitations as well as the possibilities of the clinical and biochemical applications of isotopes. The title "Isotopes in Medicine" is misleading, since only a few of the direct applications of isotopes in medicine are discussed and a number of papers are devoted to reviews of biochemical investigations which are unlikely to exert much influence on clinical medicine for some time. This, however, is not meant as a criticism of the standard of the material, which is high, and the editor is to be congratulated on his choice.

Isotopes represent an important new weapon in the armoury of the clinician and the biochemist; but it is clear that they rarely provide a short cut to the solution of a given problem, and their use demands not only considerable technical resources but, above all, a wide knowledge and experience of the particular field in which they are to be applied. The use of radioactive isotopes in radiotherapy can only be based on a wide experience of orthodox methods of radiation therapy, as is clear from the contribution to this volume by Ralston Paterson and his colleagues. In biochemical research the use of isotopes has in a number of fields raised rather than solved problems, and advances in the applications of isotopes will, to a very large extent, depend on advances in general biochemical theory and technique.

The basic problem in the clinical application of radioactive isotopes is that of obtaining adequate localization of the isotope within the required tissue. A degree of localization is required for both therapeutic and diagnostic applications, but in therapeutic work a much higher degree of localization is needed in order that the healthy tissues of the body should not suffer too great damage. The concentration of iodine by the thyroid has been made the basis of many diagnostic and therapeutic studies, which are well reviewed in this volume; but it must be admitted that the popularity of thyroid studies with iodine is largely due to the fact that iodine alone of all the elements will achieve by metabolic processes a high degree of localization within the body.

Increasing use is being made in radiotherapy of radioactive isotopes in the form of discrete sources used either externally or within the body. No papers on this aspect of the subject are included, which is perhaps reasonable since the problems are basically technical ones, and the clinical applications follow along the lines of treatment with X-rays and with radium sources. Other methods of providing a localized irradiation of the required tissues are being developed, and two of the recent techniques are discussed. A description is given of the treatment of malignant bladder conditions by a radioactive solution enclosed in a rubber balloon in the bladder, and of irradiation of the pleural and peritoneal cavities by the injection into these cavities of radioactive gold in colloidal form.

The diagnostic application of isotopes involves to a large extent radiation measurements made externally to the patient and thus must depend basically on instrumentation. An application is described of scintillation counting in an attempt to diagnose brain tumours following administration to the patient of fluorescein labelled with iodine-131. So far, in Great Britain, the results with this technique have not been very promising.

One of the most simple and direct applications of radioactive isotopes in diagnosis lies in the study of blood flow. Here a measure is required only of the rate of transport of radioactive material injected into the blood, and valuable clinical applications have been found for this technique, described in several papers of this volume.

On the technical side the volume contains a number of extremely useful articles, in particular that by L. H. Gray entitled "General Principles of Assay and Standardisation of Radioactive Isotopes". A report is also given by members of the staff of the Radiochemical Centre, Amersham, on the availability of labelled compounds, with details of the methods of synthesis of a number of compounds labelled with carbon-14.

L. F. Lamerton

* *Brit. Med. Bull.*, **8**, Nos. 2–3, 111-300 (1952), 18*s*.

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

OPEN DAYS

THE National Institute of Agricultural Engineering, at Wrest Park, Silsoe, Beds, held open days during July 22–24, when exhibits were staged to illustrate to visitors the work of the Institute. The exhibits did not cover the whole programme of the work in hand at Wrest Park (which is reported more fully in the recent report for 1949–51 [1]); but, even so, they were quite comprehensive and representative of many aspects of the activities of the departments.