

Meeting in Yugoslavia

on NUCLEAR REACTIONS

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THE Yugoslavian Summer Meeting on Nuclear Reactions was held from July 12 to 29 at Mali Lošinj, Lošinj Island, Yugoslavia. Present at the conference, which was organized by Professor Z. Janković of the Institut Rudjer Bošković in Zagreb, were seventy-two participants the majority (thirty-nine) of whom came from Yugoslavia and the others (thirty-three) from all parts of Europe. The meeting was arranged to be something between a summer school and a research conference. Every morning there were three lectures of a review nature which lasted for three hours, and in the evening an hour was devoted to a research seminar. The afternoons were left open for study and recreation.

There were five lecturers whose talks provided a framework for the conference.

A. Messiah from Saclay spoke on stripping reactions. He began by discussing the special features of stripping reactions that have singled them out from other reactions at least historically. In order to make a realistic calculation of the cross section for such a reaction, it is necessary to use the distorted-wave Born approximation as opposed to the ordinary Born approximation, and Dr. Messiah next developed the formalism underlying the distorted-wave Born approximation. He went on to discuss the well-known formulation of stripping by Butler after which he spoke of the problems encountered in including Coulomb and nuclear effects in Butler's theory. The question of the accuracy of reduced-width determinations from stripping measurements was also considered.

The Coulomb excitation reaction is not usually thought of as a nuclear reaction in the sense of a strong nuclear force phenomenon. However, its importance as a tool in nuclear spectroscopic studies has put it almost in a class by itself, and since the particle which is used to carry out the Coulomb excitation can, when its energy is high enough, begin to cause strong nuclear reactions to take place, its discussion at this meeting was very appropriate. B. R. Mottelson from Copenhagen began his discussion of this reaction by developing the classical theory of Coulomb excitation. He discussed the conditions which are necessary for the validity of the classical treatment, the general formulation and derivation of total cross sections and angular distributions, and the angular distribution of the gamma radiation following Coulomb excitation. After presenting



N. Cindro (Yugoslavia) and O. Varho (Finland). In the background is the Institute "Rudjer Bošković" where a new cyclotron is under construction.



A. Messiah (France), B. Mottelson (Denmark), O. Varho (Finland), J. Smorodinsky (Russia), K. Wildermuth (Denmark), and in front Z. Janković (Yugoslavia).



Č. Župančić of the Institute "Jožef Stefan" in Ljubljana giving one of the evening research seminars. (Photo courtesy Z. Janković.)



The final banquet. Left to right facing camera: I. Supek (Yugoslavia), Mrs. T. Gustafson (Sweden), Z. Janković (Yugoslavia), T. Gustafson (Sweden), B. Mottelson (Denmark). (Photo courtesy O. Varho.)

the quantum-mechanical theory and considering briefly higher-order excitation processes, he went on to show the type of information which has been obtained from the Coulomb excitation reaction and to outline how this information fits into the schemes proposed by the nuclear shell model and the collective model. A great deal of the information on which his lectures were based can be found in the excellent review article by Alder, Bohr, Huus, Mottelson, and Winther.¹

C. E. Porter from Los Alamos spoke about the optical model with particular emphasis on neutron scattering since it is mainly for neutrons that both the fine-structure and the gross-structure properties of the scattering have been relatively completely measured. His lectures included remarks about cross-section averages and dispersions about the average as well as the statistical distributions of fine-structure widths and the unsolved question of the statistical distribution of the fine-structure spacings.

The lectures of J. Smorodinsky from Moscow were concerned mainly with the nuclear two-body problem. He began by surveying the data on low-energy nucleon-nucleon scattering. Next he reviewed the idea of a nucleon-nucleon scattering matrix and the phase-shift analysis technique including comments on effective range theory. A great deal of emphasis in his lectures was placed on the question of the measurement and calculation of polarization effects in nucleon-nucleon scattering. He also discussed briefly the problem of the polarization of nucleons that is found in the scattering of nucleons by heavy nuclei and its probable explanation with the use of a spin orbit coupling term in the Hamiltonian. His last lectures dealt with the problem of the nucleon-nucleon interaction at very high energies with reference to some of the recent bevatron work.

An extensive discussion of photonuclear reactions was presented by K. Wildermuth of CERN. After a general review of the appropriate formulation needed to handle electromagnetic transitions and photodisintegration phenomena, he went on to consider the so-called gamma giant resonances. There have been two competing and somewhat complementary models proposed to describe these giant resonances. Both the model which pictures these resonances as resulting from collective oscillations of the protons against the neutrons and the model in which the resonances are explained on the basis of one-particle excitations in the frame of the shell model were presented. It is still an open question how the proper reconciliation of these two points of view is to be carried out; this is a difficulty which has seemed to plague the shell model and the collective model for some time and is not something peculiar only to the difficulty of explaining photonuclear reactions.

There were a number of different speakers at the research seminars in the evening; two or three were from Yugoslavia, and there were others from Denmark, France, Italy, Poland, and Russia. The topics of the discussions ranged widely from nuclear reactions to beta decay. Perhaps the major contributor to these re-

search lectures was Mottelson who gave a review of the beta-decay problem which provoked a great deal of discussion, especially since the arrival of G. Temmer from Copenhagen in between two of Mottelson's lectures with recent information on the experimental situation completely changed the conclusions Mottelson was drawing with regard to the validity of the two-component theory of the neutrino. Smorodinsky, as a close collaborator of Landau, was very glad to see that the two-component theory was still surviving experimental tests. Another of Mottelson's lectures was concerned with apparent parallelism between superconductivity and the energy gap that one seems to find in nuclear structure. He discussed the recent theory of superconductivity proposed by Bardeen which predicted rather well the superconductivity transition temperature (there were many objections to this theory on the ground that it seemed to involve a certain amount of magic which no one quite understood) and then commented briefly on how a similar approach might be used for the nuclear-structure problem. It will certainly be very interesting to see how the development of ideas along these lines proceeds.

In addition to having an opportunity to discuss physics under such pleasant conditions, there was also a chance for relaxing on the Adriatic Coast. The weather was beautiful, and hiking, swimming, and boating were among the popular diversions. It should also be said that some of the local wines were significantly different from any to which many of us had been previously exposed. It is probably fair to say that the boat trip to the island of Susak to try a different wine and a different swimming beach will be remembered for some time by those who were along. It was no fault of the organizers of the meeting that the stretch of ocean between Mali Lošinj and Susak was unusually rough on the day of the trip or that the boat behaved literally like a small cork with one wave in five flooding the decks. When it came time to return from Susak to Mali Lošinj, even the experienced captain of the boat was rather doubtful about the advisability of making a return trip that day, but somehow he was persuaded to go, and with a sizeable fraction of the passengers on the rails we arrived safely back at Mali Lošinj.

At the end of the meeting, a banquet was held at which the famous Yugoslavian *slivovitz* was the order of the day. There were a number of speeches, and this provided an occasion especially for those who had been listening rather patiently to lectures for approximately two weeks to finally be heard. After the banquet the majority of the group adjourned to a nearby hotel for wine and dancing on an outdoor dance floor, a custom which was already well entrenched even before the evening of the banquet.

Professor Janković deserves special thanks for such an excellent choice of surroundings for the meeting. It is to be hoped that this, the second of such conferences, is sufficient to establish them as a tradition; a meeting devoted to a discussion of neutron physics is being planned for next year.

¹ Revs. Modern Phys., 28, 432 (1956).