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Struttura nucleare e collisioni di ioni pesanti

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and R. A. RICCI
Directors of the Course
and C. H. DASSO
Scientific Secretary

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a cura di R. A. BROGLIA

e R. A. RICCI

Direttori del Corso

e di C. H. DASSO

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Preface.

During the last forty years a major research effort has gone into the study of nuclei by means of probes which excite only few degrees of freedom mainly by the bombardment with light ions. The specificity of the probes allowed the identification of a rich variety of elementary modes of nuclear excitation. These investigations have led to a detailed picture of nuclei close to their ground state (*).

A special feature of the nuclear system is that the field in which neutrons and protons move in the nucleus is generated by the nucleons themselves. The nucleus thus displays both the degrees of freedom associated with the single-particle motion and the collective degrees of freedom of a droplet of quantum liquid.

When two such quantal systems interact in a heavy-ion collision one is, in many aspects, entering a new field of physics. Collisions that bring the two nuclei in close contact lead to a combined nuclear-matter system under extreme conditions which have not yet been explored. It is a major challenge to extract the nuclear-structure information contained in these reactions. During the last years different models have been proposed to meet this challenge. They are based on either the concept of the average nuclear field (KOONIN, RANDRUP, NEGELE, BROGLIA, DASSO and WINTHER), or on statistical concepts (WEIDENMÜLLER and WOLSCHIN). These two extreme pictures can expect to account for some of the features of the processes they try to describe, and a consistent model must necessarily contain ingredients from both. For example, descriptions based on the mean-field approximation have to be supplemented by collision terms, damping widths of giant reasonances, etc., while the need to include collective variables in the statistical approach has long been recognized. Nonetheless, a consistent description of the interweaving of statistical and memory-conserving processes characteristic of heavy-ion reactions at low energies is still lacking.

At the basis of the different microscopic models we find the statistical shell

---

(*) Cf., *e.g.*, the *Proceedings of the International School of Physics «Enrico Fermi» on «Elementary Modes of Excitation in Nuclei»*, edited by A. BOHR and R. A. BROGLIA (Amsterdam, 1977).

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model description of the nucleus and the nuclear-response theory. This was the subject of several contributions.

The experimental situation was reviewed by GOBBI, LEFORT and MORETTO. Of the different observables, the angular momentum absorbed by the two interacting nuclei in a heavy-ion reaction seems to provide a delicate test for the different models. This area of research was covered extensively by SPECHT, STEPHENS and DE BOER.

In his lectures, SCHIFFER brought our attention to the mass and shell structure dependence of the fusion cross-sections and discussed some of the consequences this dependence may have for the imaginary heavy-ion potential.

The mutual relation between the different models and their ability to account for the observed data was the subject of the lectures of BERTSCH.

As expected from a school covering a rapidly developing field, there were no final answers to many of the questions raised during the two weeks. We are still far from being able to use heavy-ion reactions to obtain detailed nuclear-structure information. The material presented in these proceedings shows, however, that considerable progress has been made towards this end.

On behalf of all the participants of the Course we would like to thank the Italian Physical Society for providing the grants for this Course as well as for making available the inspiring facilities of Villa Monastero at Lake Como. The advice and help of Dr. P. F. BORTIGNON at different stages of the organization of the school is gratefully acknowledged. The assistance of the secretarial staff headed by G. WOLZAK played a central role in making the stay at Varenna a most enjoyable experience.

R. A. BROGLIA, C. H. DASSO and R. A. RICCI

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