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Edited by Nikola Cindro, Petar Kulišić, and Theo Mayer-Kuckuk

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PREFACE

This Conference was devoted to the study of intermediate processes in nuclear reactions. Included in this somewhat vague term today are reactions that can not be interpreted in terms of either the direct reaction model or the statistical model of nuclear reactions. They give rise to a particular energy dependence of the average cross section; a dependence characterized by an intermediate width of typically several hundred keV. In this sense "intermediate structure" in the cross sections can be understood as a deviation from the statistical model, localized in energy.

Progress in understanding the dynamics of reaction processes has led to the idea that simple model of excitation may be able to reproduce this characteristic energy dependence (i.e. increased particle widths) just as the dipole state produces a localized enhancement of the radiative width. Intermediate reactions would be then one of several line broadenings observed in nuclear physics.

The next step in understanding these processes was to identify the simple configurations associated with intermediate structure in nuclear reactions. The discovery of intermediate analogue resonances showed that nuclear models can be useful even at the highest excitation energies. This discovery prompted in some way the marriage of simple nuclear structure models, in particular the shell model, to nuclear reaction theory. The first successful result of this marriage was the concept of doorway states, i.e. simple states strongly coupled to the entrance channel. However, the concept of simplicity of a nuclear configuration is very much model dependent. A single particle state is simple in a shell model representation but fairly complicated in a phonon representation and vice versa. This implies that the nature and the number of doorway states will be model dependent. In spite of this difficulty the doorway state approach has the great advantage that it enables the intermediate resonances to be treated as any other simple resonances, provided that we add to the total width a term called the spreading width $\Gamma^{\downarrow}$. The spreading width accounts for the fact that the doorway state is not an eigenvalue of the nuclear hamiltonian and that it may dissolve into more complex configurations. Thus the probability of finding a nucleus in a doorway state decreases with time.

The following questions then arise: Is the physics of intermediate processes in nuclear reactions interesting? Is it a general phenomenon or does it occur only in very special cases? If the former is true, why it is not seen more often? In fact, only three classes of nuclear reactions can be clearly and unambiguosly classified as intermediate resonances:

- the isobaric analogue resonances
- the giant dipole resonance and
- the resonances in neutron induced fission.

What about the large variety of other nuclear processes? These problems find - or do not find - answers in the ten papers that comprise the Proceedings, summarized in the contribution by H. Feshbach.

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The Proceedings start, appropriately, with the survey of C. Mahaux on the present state of intermediate reaction theories and experiments. Mahaux's approach is model dependent, and, for many and obvious reasons, is based on the shell model, which has been so successfully employed in nuclear structure calculations.

The two following papers on the preequilibrium emission of particles (by M. Blann and by E. Gadioli and L. Milazzo-Colli) are in a sense the application of these concepts. They answer the question of what happened on the way to equilibrium? While the exciton model (Griffin, 1966) used by the Milano group has the physical transparency of the early statistical models, the hybrid model of Blann allows also the calculation of absolute cross sections by introducing a microscopic description of the collision process.

A large group of papers (D. Sperber, W. Scheid et al.,R. Stokstadt et al.and M. Petrascu) review the occurrence of intermediate states in different nuclear processes.

D. Sperber calculates the neutron evaporation and prompt fission in a rigorous way with no apparent adjustable parameters. The intermediate structure in these cross sections is reproduced by modifying the statistical treatment.

Two papers (W. Scheid et al., R. Stokstadt et al.) relate the hot topic of intermediate structure in heavy ion reactions. The concept of simple configuration in this case is related to the spatial distribution of two large, well separated groups of nucleons. The quasi-molecular and/or alpha particle configurations are introduced as possible doorway states. Paradoxically, the problem in using such concepts to treat intermediate structure in heavy ion reactions is not to explain how and why resonances stick out in a region where the density of compound nu-

cleus levels reaches 10^4/ MeV, but why it does not happen in all or most of the cases.

Although isobaric analogue resonances are considered intermediate resonances par excellence, this subject has not been treated explicitly in the Conference. The article by M. Petrascu relates the topics relevant, at the present stage of knowledge, to the subject of intermediate analogue resonances as intermediate structure. Similarly, F. Cvelbar introduces fast neutron radiative capture as intermediate processes governed by a direct-semidirect mechanism; the gross structure and the energy spectra arise from the coupling of the incident particle to the collective states of the target nucleus. The contribution of P. Brentano deals with doorway states as poles of the average S-matrix. The treatment is slightly more restrictive then the usual one, since it requires additional limitations on the spreading width, $\Gamma^{\downarrow}$.

Finally, the subject of simple structure in the exit channels is treated by L. Papineau. Here the simple structure is produced by selection rules other those related to isospin conservation.

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A conference is always both a scientific and organizational endeavour. The Europhysics Study Conferences were modelled having in mind the Gordon Research Conferences, so popular in the U.S. This has meant devoting more time to invited review papers than to short communications and also providing both a place and time for the participants to interact informally. We felt, thus, that the location of the first Europhysics Study Conference in the field of nuclear physics in the marvelous setting of the Plitvice Lakes was quite appropriate. In another sense, this Conference continued the heritage of the Adriatic Summer Meetings in Physics, one of the earliest regular international physics meetings in Europe.

The Conference was made possible by the financial support of the Council for Scientific Research of the Socialist Republic of Croatia, the Volkswagen Foundation and the Institute "Rudjer Bošković"; we acknowledge here our indebtedness to these organizations. Thanks are also due to the Institutions which contributed organizational support to the Conference: the Union of Physicists, Mathematicians and Astronomers of Yugoslavia, the Physics Department, Faculty of Electrical Engineering, Zagreb and the Institute of Nuclear Physics of the University, Bonn.

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Zagreb and Bonn, June 1973 The Editors

Contents

List of Participants

1. ALBRECHT, R.	Max Planck Institut für Kernphysik, Heidelberg, Germany
2. BISPLINGHOFF, J.	Institut für Strahlen und Kernphysik der Universität Bonn, Bonn, Germany
3. BLANN, M.	Nuclear Structure Laboratory, Univ. of Rochester, Rochester, USA
4. BLEULER, K.	Institut für Theoretische Kernphysik der Universität Bonn, Bonn, Germany
5. BLINOWSKA, K.	Institute of Experimental Physics, Warsaw, Poland
6. BOHLEN, H.G.	Max Planck Institut für Kernphysik, Heidelberg, Germany
7. BOHNE, W.	Hahn-Meitner Institut, Berlin, Germany
8. BONDORF, J.	Niels Bohr Institute, Copenhagen, Denmark
9. BORMANN, M.	I. Institut für Experimentalphysik, Hamburg, Germany
10. BRENTANO, P.	Institut für Kernphysik, Universität zu Köln, Köln, Germany
11. BRZOSKO, J.	Joint Insitutute of Nuclear Research, Dubna, USSR
12. BUCK, W.	Physikalisches Institut der Universität Tübingen, Germany
13. CHARLES, P.	C E N Saclay, France
14. CHEVARIER, A.	Institut de Physique Nucléaire, Villeurbanne, France
15. CHEVARIER, N.	Institut de Physique Nucléaire, Villeurbanne, France
16. CINDRO, N.	Institute "R. Bošković", Zagreb, Yugoslavia
17. CVELBAR, F.	Institute "J. Stefan", Ljubljana, Yugoslavia
18. CUNHA, J.D.	Laboratorio de Fisica e Engenharia Nucleares, Sacavém, Portugal

19. ČAPLAR, R.	Institute "R. Bošković", Zagreb, Yugoslavia
20. DAVIDSON, W.F.	Kernforschungsanlage Jülich, Germany
21. DEMEYER, A.	Institut de Physique Nucléaire, Villeurbanne, France
22. DERRIEN, H.	C.E.N. de Saclay, France
23. DIEHL, H.	Institut für Theoretische Physik der Universität, Frankfurt/M, Germany
24. DRENTJE, A.G.	Kernphysisch Versneller Instituut, Groningen, The Netherlands
25. ERNST, J.	Institut für Strahlen und Kernphysik der Universität, Bonn, Germany
26. FESHBACH, H.	Massachusetts Institute of Technology, Cambridge, USA
27. GADIOLI, E.	Istituto di Fisica dell'Universita, Milano, Italy
28. GRUHLE, W.	Institut für Kernphysik der Universität Köln, Germany
29. HATEGAN, C.	Institute for Atomic Physics Bucharest, Romania
30. HOLUB, E.	Institute "R. Bošković", Zagreb, Yugoslavia
31. IORI, I.	Istituto di Fisica dell'Universita, Milano, Italy
32. JEAN, M.	Institut de Physique Nucléaire Orsay, France
33. KRETSCHMER, W.	Physikalisches Institut der Universität Erlangen, Germany
34. KULIŠIĆ, P.	Institute "R. Bošković", Zagreb, Yugoslavia
35. KUZMINSKI, J.	Institute of Physics, Silesian University, Katowice, Poland
36. LALOVIĆ, B.	Institute "B. Kidrič",Belgrade, Yugoslavia
37. LIU, Q.	Hahn Meitner Institut Berlin, Germany
38. LOVAS, I.	Central Research Institute for Physics, Budapest, Hungary
39. MAHAUX, C.	Université de Liege, Belgium
40. MARIĆ, Z.	Institute of Physics, University of Belgrade, Yugoslavia

41. MAYER-BÖRICKE, C.	Institut für Kernphysik der KFA, Jülich, Germany
42. MAYER-KUCKUK, T.	Institut für Strahlen und Kernphysik der Universität Bonn, Germany
43. MITTIG, W.	C.E.N. de Saclay, France
44. MORGENSTERN, H.	Hahn-Meitner Institut Berlin, Germany
45. MYSLEK, B.	Institute for Nuclear Research, Swierk near Warsaw, Poland
46. NASH, G.F.	Institute"R. Bošković", Zagreb, Yugoslavia
47. NEWSTEAD, C.	Kernforschungszentrum Karlsruhe, Germany
48. OBLOŽINSKÝ, P.	Institute of Physics, Slovak Academy of Science, Bratislava, Czechoslovakia
49. PAAR, V.	Institute "R. Bošković", Zagreb, Yugoslavia
50. PAPINEAU, L.	C.E.N. Saclay, France
51. PATIN, Y.	C.E.A. Paris, France
52. PETRASCU, M.	Institute of Atomic Physics, Bucharest, Romania
53. PISK, K.	Institute "R. Bošković", Zagreb, Yugoslavia
54. RADJA, L.	Faculty of Electrical Engineering Split, Yugoslavia
55. RAUCH, F.	Institut für Kernphysik der Universität Frankfurt/M, Germany
56. ROHWER, T.	Physikalisches Institut der Universität Tübingen, Germany
57. RONSIN, G.	Institut de Physique Nucléaire, Orsay, France
58. SAETTA-MENICHELLA, E.	C.I.S.E. Milano, Italy
59. SCHEID, W.	Institut für Theoretische Physik der Universität Frankfurt/M, Germany
60. SPERBER, D.	Rensselaer Polytechnic Institute, Troy, USA
61. STOKSTAD, R.G.	Yale University, USA
62. STÄBLER, A.	Physikalisches Institut der Universität Tübingen, Germany
63. STRZALDOWSKI, A.	Institute of Nuclear Physics Cracow, Poland

64. TOKE, J. — Institute of Experimental Physics
Warsaw, Poland

65. TURKIEWICZ, I. — Institute of Nuclear Research
Warsaw, Poland

66. TURKIEWICZ, J. — Institute of Nuclear Research
Warsaw, Poland

67. VOSS, F. — Institut für Angewandte Kernphysik
Kernforschungszentrum, Karlsruhe,
Germany

68. VULETIN, J. — Faculty of Electrical Engineering
Split, Yugoslavia

69. ZORAN, V. — Max Planck Institut für Kernphysik
Heidelberg, Germany