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Volume 948

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The Euroschool on Exotic Beams - Vol. 5

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ISSN 0075-8450

ISSN 1616-6361 (electronic)

Lecture Notes in Physics

ISBN 978-3-319-74877-1

ISBN 978-3-319-74878-8 (eBook)

<https://doi.org/10.1007/978-3-319-74878-8>

Library of Congress Control Number: 2014930224

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Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature.

The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This book is the fifth volume of a series of Lecture Notes in Physics, which emerged from the Euroschool on Exotic Beams. This book appears in 2018, when the 25th anniversary of the establishment of this school will take place. This anniversary will be celebrated in August in Leuven (Belgium), where the Euroschool started in 1993. With one exception (in 1999), the Euroschool on Exotic Beams has been held every year, first in Leuven from 1993 to 2000, and then, starting in 2001, it travelled to various places in Europe: Finland (2001, 2011), France (2002, 2007, 2017), Spain (2003, 2010), United Kingdom (2004), Germany (2005, 2016), Italy (2006), Poland (2008), Belgium (2009), Greece (2012), Russia (2013), Italy (2014), and Croatia (2015). Based on lectures given at these Euroschool events, the Lecture Notes provide an introduction, for graduate students and young researchers, to novel and exciting fields of physics with radioactive ion beams and their applications. The fifth volume in this series covers topics that were presented in Euroschool lectures between 2006 and 2015 and comprises recent updates.

Current research in nuclear physics aims at a comprehensive understanding and description of atomic nuclei and their properties, based on their fundamental degrees of freedom, protons and neutrons, and their interaction. The field has advanced tremendously with the advent of radioactive ion-beam facilities and intense stable beams, which allow the production and study of exotic nuclei, i.e., short-lived nuclei far-off stability, and superheavy elements. These studies opened the pathway to the *terra incognita* of the nuclear chart, leading, for instance, to the discovery of new chemical elements, novel magic numbers in nuclei with a large neutron excess, and new phenomena, such as neutron skins and collective excitations, in which these neutron skins oscillate against a rigid nuclear core. Laboratory access to exotic nuclei is also essential for the understanding of many astrophysical objects whose dynamics and associated nucleosynthesis are driven by short-lived nuclei. A new degree of freedom to study the strong interaction in nuclei has been opened up by hypernuclei, which involve hyperons, i.e., baryons that contain at least one strange quark. Studies of the baryon-baryon interactions in hypernuclei are also an essential approach for the understanding of extreme astrophysical objects with high densities, such as the cores of neutron stars, where hyperons are predicted to

play important roles in the equation of state. This wide field, including applications in material research, biology, medicine, imaging techniques, security, and other areas, is explored on theoretical grounds and in experiments with exotic beams. These experiments are now being carried out at existing facilities and will be performed at future facilities. It is the goal of the Euroschool lectures and the present Lecture Notes to fill the gap between classical university education and research life in laboratories, and in this way to contribute to the education of the next generation of scientists, who will explore the *terra incognita*. Also, the Nuclear Physics European Collaboration Committee (NuPECC) states, in its Long Range Plan 2017, that activities such as the Euroschool on Exotic Beams are vital for training highly qualified researchers in nuclear science and are a very important element for maintaining development in the field. In the very first original funding request for the Euroschool on Exotic Beams, which was submitted to the European Commission in 1992, we read: “The school forms an ideal basis for exchange of technical and scientific know-how, and for mobility between different research institutes and universities”. Now, 25 years later, this statement is still valid, and the Euroschool’s Board of Directors, which organizes the Euroschool every year, is indebted to this mission.

Clearly, the present book cannot cover all the topics and methods in the broad field of radioactive beams. Therefore, with this fifth volume, we follow the previous examples and have selected topics from the traditional core of the field of exotic nuclei (fission, alpha decays, giant resonances) and included new directions (hypernuclei and nucleon resonances) and applied areas (laser acceleration and dating methods). None of these topics has been treated before in this series; therefore, the present volume complements the previous editions. This is an indicator of the breadth and prosperity of an active field. Owing to the engagement of Euroschool lecturers who are world class experts in their domains, the Euroschool Lecture Notes are a valuable asset for the high-level education of present and next-generation scientists. We hope that this volume will be as useful and as successful as the previous ones.

It is our pleasure to thank the sponsors for their support over many years; this support makes the Euroschool events possible and contributes to the education of next-generation scientists. The sponsors, to whom we are indebted, are:

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- ECT*, European Centre for Theoretical Studies in Nuclear Physics and Related Areas, Trento (Italy)
- GANIL; Grand Accélérateur National d’Ions Lourds, Caen (France)
- Gobierno de España; Ministerio de Economía y Competitividad FANUC Network and CPAN Ingenio 2010, Madrid (Spain)
- GSI; Helmholtz Centre for Heavy Ion Research, Darmstadt (Germany)
- HIC-4-FAIR; Helmholtz International Center for FAIR, Darmstadt (Germany)

- IFIC-CSIC; Instituto de Fisica Corpuscular, Consejo Superior de Investigaciones Cientificas, Madrid (Spain)
- INFN; Istituto Nazionale di Fisica Nucleare (Italy)
- INFN-LNL; Laboratori Nazionali di Legnaro (Italy)
- IRB; Institut Ruder Boskovic (Croatia)
- ISOLDE-CERN, Geneva (Switzerland)
- JINR; Joint Institute for Nuclear Research, Dubna (Russia)
- JYFL; University of Jyväskylä (Finland)
- KU Leuven; Instituut voor Kern- en Stralingsfysica, Leuven (Belgium)
- KVI-CART; Center for Advanced Radiation Technology, Groningen (The Netherlands)
- UCL; Centre de Ressources du Cyclotron, Louvain-la-Neuve (Belgium)
- Università degli Studi di Padova (Italy)
- University of Warsaw (Poland)
- University of Zagreb (Croatia)
- USC; University of Santiago de Compostela (Spain).

At this point, we would like to thank all those who have contributed to this volume in various ways. We owe the lecturers the largest debt of gratitude, for their efforts in preparing and giving the excellent lectures for Euroschool participants, and for their dedication of much time and effort to the preparation of the contributions to this book: very warm thanks for writing these educational and understandable pieces for our students! Next, we would like to thank all the members of the Board of Directors of the Euroschool on Exotic Beams, who inspired the development of this book with their many ideas. Finally, it is, once more, our pleasure to thank Dr. Chris Caron and his colleagues at Springer Verlag for their encouragement and continuous support in a fruitful collaboration.

Warsaw, Poland
Darmstadt/Giessen, Germany
November 2017

Marek Pfützner
Christoph Scheidenberger

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