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J. Al-Khalili E. Roeckl (Eds.)

The Euroschool Lectures on Physics with Exotic Beams, Vol. I

Springer

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Preface

In recent years a new scientific discipline has emerged in nuclear physics research worldwide: the production and use of energetic radioactive beams. The study of the atomic nucleus, the tiny core of the atom and carrier of essentially all of the visible mass in the Universe, has undergone a major re-orientation in the past two decades and has seen the emergence of a new frontier. The availability of energetic beams of short-lived (radioactive) nuclei, referred to as 'radioactive ion beams (RIB) or exotic nuclear beams', has opened the way to the study of the structure and dynamics of thousands of nuclear species never before studied in the laboratory. These exotic beams, produced by two complementary techniques (in-flight separation and post-acceleration of low-energy radioactive beams), have been developed in a number of European Large-Scale Facilities. A very promising way towards establishing an accurate and globally applicable description of the inner workings of atomic nucleus is the study of exotic nuclei. Pioneering experiments and vigorous development programmes are ongoing in Europe, North America and Japan on existing facilities. In addition, a new generation of large-scale RIB facilities is being built.

While the field of RIB physics is linked mainly to the study of nuclear structure under extreme conditions of isospin, mass, spin and temperature, it also addresses problems in nuclear astrophysics, solid-state physics and the study of fundamental interactions. Furthermore important applications and spin-offs also originate from this basic research. There is hence little doubt that RIB physics has transformed not only nuclear science but many related areas too.

Due to the fact that one is not limited anymore to the proton/neutron ratio of stable-isotope beams, virtually the whole chart of the nuclides opens up for research. Theoretical models can be verified up to the limits of the existence of nuclear matter: it is clear that the focus on this isospin degree of freedom will lead to better insights into the validity of present models and eventually to a new and more complete description of the atomic nucleus.

It has been the aim of the series of Euro (Summer) Schools on which the lectures in this volume are based to train PhD students and young post-docs starting to work in the field of RIB physics. The series first started in 1993 under the name Euroschools on Exotic Beams, an EU supported initiative started by Mark Huyse and Piet Van Duppen, and continued in 2002-2006 as the EU funded EURO SUMMER SCHOOLS ON EXOTIC BEAMS. At each of these Schools, six leading researchers in the field from around the world are invited to lecture on their topic. The lectures range over the subjects of nuclear theory, experiment, technical developments (in accelerator and detector design) as well as wider applications in related fields such as astrophysics and nuclear medicine.

This volume of *Lecture Notes in Physics* is the first in the series of a collection of lectures from recent Schools. It is aimed at a readership similar to those attending the Schools and should provide a helpful reference for young researchers entering the field and wishing to get a feel for contemporary research in a number of areas. The contributions are in the style of lecture notes that might be provided to new PhD students and which therefore have a reasonably long shelf-life. Unlike research papers or review articles, they are not meant to contain all the latest results or to provide an exhaustive coverage of the field but pedagogical introductions to the subject with examples.

We wish to point out that the contributions in this first volume are by lecturers chosen from among all previous Schools who have updated their material to incorporate recent advances and results. They were chosen by the editors in order to cover a selection of topics that span the field of RIB physics, from theory and experiment to techniques, applications and related areas. Naturally, since this is only the first volume of the *Lecture Notes in Physics* series for the School it is anticipated that the 'backlog' of lectures will eventually be dealt with, as each volume will contain roughly two years worth of School lectures.

Finally, we would like to thank our co-lecturers for their valuable contributions to this volume and Dr Chris Caron and his colleagues at Springer-Verlag for their help and fruitful collaboration in this matter.

J.S. Al-Khalili and E. Roeckl (Editors)

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