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

 Springer

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Preface

This is the second volume in a series of lecture notes based on the highly successful Euro Summer School on Exotic Beams that has been running yearly since 1993 (apart from 1999) and is planned to continue to do so. It is the aim of the School and these lecture notes to provide an introduction to radioactive ion beam (RIB) physics at the level of graduate students and young postdocs starting out in the field. Each volume will contain lectures covering a range of topics from nuclear theory to experiment to applications.

Our understanding of atomic nuclei has undergone a major re-orientation over the past two decades and seen the emergence of an exciting field of research: the study of exotic nuclei. The availability of energetic beams of short-lived nuclei, referred to as radioactive ion beams (RIBs), has opened the way to the study of the structure and dynamics of thousands of nuclear species never before observed in the laboratory. In its 2004 report “Perspectives for Nuclear Physics Research in Europe in the Coming Decade and Beyond”, the Nuclear Physics European Collaboration Committee (NuPECC) states that the field of RIB physics is one of the most important directions for the future science programme in Europe. In 2005 it published its “Roadmap for Construction of Nuclear Physics Research Infrastructures in Europe”. In addition, the NuPECC report Nuclear Science in Europe: Impact, Applications, Interactions (June 2002) highlighted just how widely RIB physics impacts other areas, from energy and the environment to medicine and materials science. There is little doubt that RIB physics has transformed not only nuclear physics itself but many other areas of science and technology too, and will continue to do so in the years to come.

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. The development of new production, acceleration and ion storing techniques and the construction of new detectors adapted to work in the special environment of energetic radioactive beams is also an important part of the science. And, due to the fact that one is no longer limited to the proton/neutron ratio of stable-isotope beams, virtually the whole chart of the nuclei opens up for research, so theoretical

models can be tested and verified all the way up to the limits of nuclear existence: the proton and neutron drip lines.

The beams of rare and exotic nuclei being produced are via two complementary techniques: in-flight separation and post-acceleration of low-energy radioactive beams. Both methods have been developed in a number of European large scale facilities such as ISOLDE (CERN, Switzerland), GANIL (Caen, France), GSI (Darmstadt, Germany), the Accelerator Laboratory of the University of Jyväskylä (Finland), INFN Laboratori Nazionali di Legnaro (Italy) and the Cyclotron Research Centre (Louvain-la-Neuve, Belgium). Indeed, so important is the continued running and success of the School that a number of these European facilities have committed to providing financial support over the coming years.

Volume I of this series has proved to be highly successful and popular with many researchers reaching for it for information or providing it for their PhD students as an introduction to a particular topic. We stress that the contributions in these volumes are not review articles and so are not meant to contain all the latest results or to provide an exhaustive coverage of the field but written in the pedagogical style of graduate lectures and thus have a reasonably long ‘shelf life’. As with the first volume, the contributions here are by leading scientists in the field who have lectured at the School. They were chosen by the editors to provide a range of topics within the field and will have updated their material delivered at the School (sometimes several years ago) to incorporate recent advances and results.

Finally, we wish to thank the lecturers who have contributed to this volume for their hard work and diligence, and indeed for their patience. It is difficult to find the time to lay out a subject in such a careful, thorough and readable style. We also wish to thank Dr Chris Caron and his colleagues at Springer-Verlag for the help, fruitful collaboration and continued support on this project.

March 2006

Jim Al-Khalili
Ernst Roeckl

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