Preface

This is the second volume in a series of *Lecture Notes in Physics* entitled "Clusters in Nuclei" based on the well known Cluster Conferences that have been running since decades, on two recent **State Of The Art in Nuclear Cluster Physics** Workshops, as well as on successfull Theoretical Winter Schools, traditionally held on the Campus of the Université de Strasbourg.

A great deal of research work has been done in the field of alpha clustering and in cluster studies of light neutron-rich nuclei. The scope of this new Series of lecture notes is to deepen our knowledge of the field of nuclear cluster physics which is one of the domains of heavy-ion nuclear physics facing the greatest challenges and opportunities.

The purpose of this second volume of *Lecture Notes in Physics* **Clusters in Nuclei**, is to promote the exchange of ideas and discuss new developments in "Clustering Phenomena in Nuclear Physics and Nuclear Astrophysics" from both the theoretical and experimental points of views. It is aimed to retain the pedagogical nature of our earlier Theoretical Winter Schools and should provide a helpful reference for young researchers entering the field and wishing to get a feel of contemporary research in a number of areas.

The various aspects of the main topics in this second volume of **Clusters in Nuclei** are divided into six chapters, each highlighting new ideas that have emerged in recent years:

- Microscopic Cluster Models
- Neutron Halo and Breakup Reactions
- Breakup reaction models for two- and three-cluster projectiles
- Clustering Effects within the Dinuclear Model
- Nuclear Alpha-Particle Condensates
- Clusters in Nuclei: Experimental Perspectives

The first chapter entitled **Microscopic Cluster Models** by Descouvemont and Dufour shows how clustering aspects can be fairly well described by microscopic cluster models such as the Resonating Group Method or the Generator Coordinate Method (GCM). For the sake of pedagogy, the formalism is presented in simple conditions by assuming spinless clusters and single-channel calculations. Extensions of the GCM to multicluster and multichannel calculations are compared to different three-alpha descriptions of ^{12}C proposed as typical illustrative examples.

The second chapter of Nakamura on **Neutron Halo and Breakup Reactions** connects the phenomenological aspects of neutron halos to experimental results collected for breakup reactions at intermediate/high energies. Nakamura investigates the breakup reactions as playing significant role in elucidating exotic structures along the neutron drip line. This study is be very important for further investigations of drip-line nuclei towards heavier mass regions available with the new-generation Radioactive Ion Beam (RIB) facilities: SPIRAL2, FAIR etc. in Europe, RIBF and KoRIA in Asia and FRIB in the US.

Breakup reaction models for two- and three-cluster projectiles are deeply discussed in Chap. 3 by Baye and Capel to provide a precise reaction picture coupled to a fair description of the projectile. The projectile is assumed to possess a cluster structure revealed by the dissociation process. This cluster structure is described by a few-body Hamiltonian involving effective forces between the clusters. Within this assumption, various reaction models are reviewed.

The Chap. 4 entitled **Clustering Effects within the Dinuclear Model** by Adamian, Antonenko and Scheid describes clustering of two nuclei as a dinuclear system (DNS) following Volkov ideas. The problems of fusion dynamics in the production of superheavy nuclei, of the quasifission process and of multi-nucleon transfer between nuclei are revisited within the DNS concept. Similarly, ternary fission processes are discussed within the scission-point picture.

Yamada, Schuck and their collaborators are trying in Chap. 5 (**Nuclear Alpha-Particle Condensates**) to definitively demonstrate that a typical alpha-particle condensate is the Hoyle state of ^{12}C, which plays a crucial role for the synthesis of light-mass elements in the universe. It is conjectured that alpha-particle condensate states also exist in heavier n alpha nuclei in qualitative agreement with the experimental observations presented in Vol.1 by von Oertzen in his lecture notes.

Finally, the last chapter **Clusters in Nuclei: Experimental Perspectives** proposed by Papka treats most of experimental aspects of nuclear cluster states studies from traditional techniques to the most recent developments and emerging methods. Many aspects of acceleration, including high-intensity, low-energy and radioactiveion beams are detailed in the context of nuclear clustering. The interest in combining radioactive beams and active targets are also addressed in terms of new perspectives and possible fields of future investigations.

Each forthcoming volume will also contain lectures covering a wide range of topics from nuclear cluster theory to experimental applications that have gained a renewed interest with available RIB facilities and modern detection techniques. We stress that the contributions in this volume and the following ones 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 are written instead in the pedagogical style of graduate lectures and thus have a reasonable long ‘shelf life’.

The edition of this book could not have been possible without stimulous discussions with Profs. Greiner, Horiuchi, and Schuck. Our appreciation goes to all our co-lectures for their valuable contributions. We acknowledge also all the referees for their comments on the chapters that are included in this volume. I would like here to thank, more particularly, Prof. Poenaru for his constant helpfull suggestions from the beginning to the end. Special thanks go Dr. Christian Caron and all the members of his Springer-Verlag team (in particular, Mrs Angela Schulze-thomin and Gabriele Hakuba) for their help, fruitful collaboration and continuedsupport for this ongoing project.

Strasbourg, May 2011 Christian Beck

Springer

http://www.springer.com/978-3-642-24706-4

Clusters in Nuclei, Vol.2
Beck, C. (Ed.)
2012, XV, 353 p. 167 illus., Softcover
ISBN: 978-3-642-24706-4