Particles and Nuclei

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An Introduction to the Physical Concepts

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Springer

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Preface to the Sixth Edition

The original chapters on deep inelastic scattering were formulated in 1993. Since this time a large amount of new experimental data have been obtained at the Electron-Proton Collider HERA at DESY in Hamburg. In summer of 2007 the Collider was turned off. The chapters 7 and 8 were partially rewritten as to include the most spectacular new results on deep inelastic scattering.

I would like to thank Tina Pollmann for preparing the figures and Jürgen Sawinski for the formatting of the Sixth Edition.

Heidelberg, February 2008 *Bogdan Povh*

Preface to the Fourth and the Fifth Edition

In the last two editions we included new results on the neutrino oscillations as evidence for a non-vanishing mass of the neutrinos.

In the present edition we have rewritten the chapter on "Phenomenology of the Weak Interaction" (Chapter 10) in order to give a coherent presentation of the neutrino properties. Furthermore, we extended the chapter on "Nuclear Thermodynamics" (Chapter 19).

Heidelberg, July 2006 *Bogdan Povh*

Preface to the First Edition

The aim of PARTICLES AND NUCLEI is to give a unified description of nuclear and particle physics because the experiments which have uncovered the substructure of atomic nuclei and nucleons are conceptually similar. With the progress of experimental and theoretical methods, atoms, nuclei, nucleons, and finally quarks have been analysed during the course of this century. The intuitive assumption that our world is composed of a few constituents — an idea which seems attractive, but could not be taken for granted — appears to be confirmed. Moreover, the interactions between these constituents of matter can be formulated elegantly, and are well understood conceptionally, within the so-called "standard model".

Once we have arrived at this underlying theory we are immediately faced with the question of how the complex structures around us are produced by it. On the way from elementary particles to nucleons and nuclei we learn that the "fundamental" laws of the interaction between elementary particles are less and less recognisable in composite systems because many-body interactions cause greater and greater complexity for larger systems.

This book is therefore divided into two parts. In the first part we deal with the reduction of matter in all its complication to a few elementary constituents and interactions, while the second part is devoted to the composition of hadrons and nuclei from their constituents.

We put special emphasis on the description of the experimental concepts but we mostly refrain from explaining technical details. The appendix contains a short description of the principles of accelerators and detectors. The exercises predominantly aim at giving the students a feeling for the sizes of the phenomena of nuclear and particle physics.

Wherever possible, we refer to the similarities between atoms, nuclei, and hadrons, because applying analogies has not only turned out to be a very effective research tool but is also very helpful for understanding the character of the underlying physics.

We have aimed at a concise description but have taken care that all the fundamental concepts are clearly described. Regarding our selection of topics, we were guided by pedagogical considerations. This is why we describe experiments which — from today's point of view — can be interpreted in a

straightforward way. Many historically significant experiments, whose results can nowadays be much more simply obtained, were deliberately omitted.

Particles and Nuclei (Teilchen und Kerne) is based on lectures on nuclear and particle physics given at the University of Heidelberg to students in their 6th semester and conveys the fundamental knowledge in this area, which is required of a student majoring in physics. On traditional grounds these lectures, and therefore this book, strongly emphasise the physical concepts.

We are particularly grateful to J. Hüfner (Heidelberg) and M. Rosina (Ljubljana) for their valuable contributions to the nuclear physics part of the book. We would like to thank D. Dubbers (Heidelberg), A. Fäßler (Tübingen), G. Garvey (Los Alamos), H. Koch (Bochum), K. Königsmann (Freiburg), U. Lynen (GSI Darmstadt), G. Mairle (Mannheim), O. Nachtmann (Heidelberg), H. J. Pirner (Heidelberg), B. Stech (Heidelberg), and Th. Walcher (Mainz) for their critical reading and helpful comments on some sections. Many students who attended our lecture in the 1991 and 1992 summer semesters helped us through their criticism to correct mistakes and improve unclear passages. We owe special thanks to M. Beck, Ch. Büscher, S. Fabian, Th. Haller, A. Laser, A. Mücklich, W. Wander, and E. Wittmann.

M. Lavelle (Barcelona) has translated the major part of the book and put it in the present linguistic form. We much appreciated his close collaboration with us. The English translation of this book was started by H. Hahn and M. Moinester (Tel Aviv) whom we greatly thank.

Numerous figures from the German text have been adapted for the English edition by J. Bockholt, V. Träumer, and G. Vogt of the Max-Planck-Institut für Kernphysik in Heidelberg.

We would like to extend our thanks to Springer-Verlag, in particular W. Beiglböck for his support and advice during the preparation of the German and, later on, the English editions of this book.

Heidelberg, May 1995

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