Preface

Despite their intriguing simplicity two-body atomic systems such as the *hydrogen atom* continue to challenge physicists even after more than a century of research. The hydrogen atom has inspired the development of the fundamental theories on which our modern physical understanding of the world is based. Several simple atoms have been thoroughly studied over many decades. The hydrogen atom is the simplest and experimentally best accessible of them. The understanding of its spectra was something of a *Rosetta stone* in unveiling the laws of *Quantum Mechanics* in the first three decades of the twentieth century and – furthermore – was the spark that ignited the development of modern *Quantum Electrodynamics* (QED) after the discovery of the *Lamb shift* and an *anomaly* in the hyperfine structure interval in the ground state half a century ago.

The list of simple atoms accessible now includes a broad range of very different natural and artificial systems: hydrogen, helium, muonium, positronium, various few-electron ions, muonic atoms and exotic atomic systems containing a pion, antiproton etc. While hydrogen atoms form the essential part of our universe, the unstable atoms like muonium do not exist in nature at all. The investigation of simple atoms has provided us with important knowledge on fundamental interactions between the particles these atoms consist of.

Today, the simple atoms are still an important object of study, but nowadays they play a different role. The theory of such atoms, *bound state QED*, is a fruitful training ground for bound state Quantum Chromodymanics (QCD), the theory of *strong interactions*, and for few-body nuclear theory. The study of common atoms, such as hydrogen and deuterium, is opening intriguing new frontiers of higher and higher accuracy through new experimental technology, such as an entirely new approach to optical frequency metrology.

In the cases of muonium, positronium, muonic atoms and multiply-charged ions, the study implies the development of new sources and new detectors. The application of spectroscopic methods is very attractive for pionic and exotic atoms, because of an extremely high (for particle physics) level of accuracy.

The accurate study of some atoms (hydrogen, deuterium, muonium, helium and hydrogen-like carbon) and some free particles (electron, proton, muon) provides us with new highly accurate values of the fundamental physical constants which are important far beyond the physics of simple atoms.

This publication summarizes the progress of the last twenty years and it presents the state of the art in the field. It contains material from two confer-

ences: *Hydrogen Atom* (Pisa, 1988) and *Hydrogen Atom 2: Precision Physics of Simple Atomic Systems*. The latter took place in Castiglione della Pescaia, Italy, from May 31–June 3, 2000. As was the case twelve years ago, it was organized as a satellite meeting to the International Conference on Atomic Physics. *The Hydrogen Atom 2* meeting involved more than one hundred scientists from around the world working on different aspects of the physics of simple atoms, and offered them the opportunity for interdisciplinary exchanges between atomic spectroscopy, atomic theory, nuclear and particle physics, metrology and quantum field theory.

Most of the contributions to the *Hydrogen Atom 2* meeting are presented in this publication. The book consists of twelve review papers devoted to the main topics of the *precision physics of simple atoms*. The CD contains the electronic version of the book and, in addition, the contributed papers and a file with a scanned copy of the conference proceedings of the first *Hydrogen Atom* meeting.

The study of such a simple thing as the hydrogen atom is indeed of general physical interest for a broad audience, while any conference proceedings reporting detailed information in the field may only be of interest to a narrower community. As a result of this, we decided to put the review papers into book form, while the contributed papers based on progress reports and poster presentations have been put onto the compact disk. We gratefully acknowledge Springer-Verlag for their understanding of the special nature of this endeavour and their agreement to promote the $book + CD$ edition.

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The *Hydrogen Atom* meeting of 2000 was the second in the series and we, as the meeting chairmen, would like to gratefully acknowledge efforts by F. Bassani, M. Inguscio and T. W. Hänsch, who initiated the meeting series and gave essential support in the organization of the second *Hydrogen* meeting.

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