

Preface

The field of nuclear physics is entering the 21st century in an interesting and exciting way. On the one hand, it is changing qualitatively since new experimental developments allow us to direct radioactive and other exotic probes to target nuclei as well as to spark off extremely energetic nuclear collisions. In parallel, detector systems are of an impressive sophistication. It is difficult to envisage all the discoveries that will be made in the near future. On the other hand, the applications of nuclear science and technology are broadening the limits in medicine, industry, art, archaeology, and the environmental sciences, etc. This implies that the public perception of our field is changing, smoothly but drastically, in contrast to former times where nuclear weapons and nuclear power plants were the dominant applications perceived by citizens. Both aspects, scientific dynamism and popular recognition, should lead the field to an unexpected revival.

One of the consequences of the former could be that many brilliant students consider nuclear physics as an excellent field in which to acquire professional expertise. Therefore, one of the challenges of the international nuclear physics community is to try to make the field attractive. That means simply being pedagogic and enthusiastic. Thus, as organisers of an already established summer school, our contribution was to put an emphasis in this session on pedagogy and enthusiasm.

Our task was threefold: to select the most outstanding and fundamental topics in nuclear physics, to choose relevant speakers in each subject, and to attract a group of brilliant young students from as many different countries as possible. The first aspect was difficult and the others were delicate, in particular the second one.

The topics we finally selected cover the field from basic and traditional ones (the nucleon–nucleon interaction, the shell model, the semiclassical approach, etc.) to topics that have arisen in recent past (the physics of radioactive beams or the phenomena that take place when the nucleus is put under extreme conditions). In all cases, the speakers accomplished our request in the sense of starting from the basic aspects of the topic if they dealt with a recent development or, on the contrary, finishing a traditional subject with the most recent discoveries. Thus, the general scope of the school and the content of this book is the responsibility of the organisers and editors who are aware that some missing topics could be considered by the nuclear community as of equal importance to those covered by the school.

The selection of the speakers, as we said before, was a delicate task. After the first discussion sessions we decided to apply the Principle of Minima, which in Spanish is formulated as: “Aunque no estén todos los que son, han de ser todos los que estén”. That means that although there are many relevant researchers in each topic, nobody can argue that the speaker we selected is not one of them. To our pleasant surprise the lecturers selected not only accepted our invitation but also the request to be pedagogic. It was not necessary to insist on conveying enthusiasm for nuclear physics to the students.

The most important part of a school is the body of students. Among the pile of application forms we received we had to select 50 from outside Seville due to the lodging limitations at the Oromana hotel where the school took place. The three criteria we applied, youth, brilliance, and diversity, were not restrictive enough and we refused some applicants that certainly deserved to participate in the school. It was a pity. The average age of the students was around 26 and they came from leading research centres in (according to the number of participants, excluding Spain) France, Belgium, Italy, USA, Germany, Sweden, UK, Russia, Czech Republic, Canada, Switzerland, Greece and South Africa. They participated actively during the time of the School in all the sessions with questions and comments. In addition, 27 of them had the opportunity of presenting their own research work in oral seminars. These seminar sessions complemented the invited lectures so as to provide participants with a flavour of what is going on presently in nuclear physics around the world. We are grateful to the students and their universities and research centres for their financial efforts in attending the School.

In spite of our interest as organisers in helping the students with some financial assistance, we were just able to provide a few of them with small grants covering part of the living expenses. The main expected support was supposed to come from the European Union through a program devoted specifically to financing conferences, workshops and summer schools. Unfortunately, our application was rejected with the argument that it had no “European added value”. They considered that the topics selected could be taught in many European universities. Certainly this is true, but this would be the case for any actual summer school. Anyway, we feel that a meeting for discussing the fundamentals and new lines of development of a basic field, such as nuclear physics, in which 65 young physicists from all over the world gather to hear the clear account of 11 top-level lecturers, always has “added value”.

In this preface we have to acknowledge all the people and organizations that helped us manage this summer school. First, our colleagues and friends at the Nuclear Physics Department at the University of Seville. All of them helped us in the different stages since they considered this School to be a collective task of the whole Department. We would like to express here our gratitude for their altruistic help. Among them we would like to mention Alberto Molina who designed the poster for the School, José Enrique García-Ramos, Curro Pérez-Bernal and Antonio Moro who assisted us continuously with their computer

skills, and José Díaz and Rosario González who took care of solving bureaucratic and administrative problems.

From the financial point of view we are grateful to the Spanish DGICYT for their important effort in covering part of the lecturers' expenses. La Junta de Andalucía through the Consejería de Educación y Ciencia supported partially the expenses related to the organization. The University of Seville helped us through three different routes: its Plan Propio, its Vicerrectorado de Extensión Universitaria, and our own Department. In addition, the bank Monte de Huelva y Sevilla provided the School with folders and writing material for the participants. We are grateful to all of them. We want them to know that their effort provided us with the opportunity to organize an excellent summer school. One of the manifestations of that excellence is this book containing the lecture notes of the meeting that we hope will be very useful for many students around the world. It can help them to know the state of the art in nuclear physics at the beginning of the 21st century and its possible lines of future development.

The book is organized as follows. First, a lecture on the more fundamental part of nuclear physics, such as the nucleon–nucleon interaction, is presented. The second lecture is devoted to the information one extracts from the atomic nucleus using electromagnetic probes. With these, among other probes, a lot of information on the spectroscopic properties of the nucleus can be obtained. However, since the detailed form of the nuclear interaction is not completely known, appropriate models have to be constructed to explain the observed properties. In the next three lessons, three of the more developed models are discussed, starting with the Nuclear Shell Model, continuing with the Collective Model, and finishing with the Interacting Boson Model. The next two lessons are devoted to microscopic extensions of these models investigating aspects beyond the concept of the mean field and the inclusion of relativistic effects. The following lesson is devoted to nuclear reactions, in particular to presenting the formalism used to study halo nuclei, nowadays of interest with the advent of radioactive beams and the possibility of exploring nuclei far from the line of stability. Powerful semiclassical theories of application in the nuclear landscape are presented in the next lesson. The topics presented in the last two lessons are related to the experimental status of the study of nuclei at the limits of the Nuclear Chart, and the behaviour of nuclei under extreme conditions, both of which are hot topics in nuclear physics. The organization of the book is of course a matter of taste and the order selected is our responsibility. However, the lessons are organized independently so that the interested reader can use his/her own order criteria.

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