Workshop in Hadron and Particle Physics

6th - 9th November 2018, Sevilla (Spain)

1. Introduction

Quantum Chromodynamics (QCD) is the strong-interaction part of the Standard Model of Particle Physics. Solving QCD presents a fundamental problem that is unique in the history of science. Never before have we been confronted by a theory whose elementary excitations are not those degrees of freedom readily accessible via experiment, that is, whose elementary excitations are confined. Moreover, QCD generates forces which are so strong that they produce about 98 % of the mass in the visible Universe, meaning that the Higgs mechanism is largely irrelevant for ordinary matter. The underlying phenomenon which generates this mass –from nothing– is dynamical chiral symmetry breaking (DCSB). Neither confinement nor DCSB are apparent in QCD's Lagrangian and yet they play a dominant role in determining the observable characteristics of real-world QCD, e.g., hadron masses and couplings. Confinement and DCSB are inherently nonperturbative phenomena, and therefore a robust understanding of hadron properties is only possible through nonperturbative methods in quantum field theory. A great international collaborative effort is necessary if we are to solve the challenges posed by Nature's most demanding physical theory

This meeting is a natural continuation of the biannual series of Workshops focusing on nonperturbative phenomena in QCD that have been held in Matalascañas (Huelva) in October 2012, Punta Umbría (Huelva) in October 2014 and Seville in October 2016. The main aim of this meeting is to reinforce and expand the collaborative research teams that were created in the past events. To achieve this central purpose, the meeting will enable participants to discuss their recent progress in phenomenological and theoretical aspects of nonperturbative QCD. It will also explore new avenues for advancing theory in order to satisfy the experimental demands. At this stage, we can conclude by highlighting that, in the last few years, very relevant high-impact publications crystallized as a result of collaborative efforts fostered by the previous workshops of our biannual series, *e.g. Phys.Lett. B742 (2015) 183-188* (71 citations in INSPIRES in two years) or the very recent *Phys.Rev. D96 (2017) no.5, 054026.* (These articles explicitly acknowledge the workshops for their role in the inception of the studies that lead to the published results.)

2. Nonperturbative QCD

The manner by which the quarks and gluons of QCD combine to form the known hadrons is as yet unknown. More striking, perhaps, is the failure to comprehend even which hadrons the theory might support. For example, QCD can potentially produce bound-states constituted solely from gluons. If a gluonic spectroscopy can be discovered and decoded, this will change the way in which we think matter is constructed. For the first time, it will be shown that the QCD's gauge boson (gluon) participates at the same level as the basic fermions of the theory (quarks) in building matter.

The basic problem lies on the fact that QCD is nonperturbative at the typical hadron scale. Therefore, the greatest novelty and the greatest challenge within the Standard Model of Particle Physics is to find appropriate theoretical tools that predict and explain precisely, via mathematics, the properties of the real-world QCD. This means that the problem of confinement must be tackled and its connection with dynamical chiral symmetry-breaking elucidated. In parallel with these fundamentals, a diverse array of physical observables must be proposed by theorists and experimentalists in order to check the tools at hand. Ideal candidates to test the phenomena of confinement and dynamical chiral symmetry-breaking, and therefrom develop an articulation of any connection between them and hadrons, are the so-called structure functions: elastic and transition form factors, (general) parton distribution amplitudes and fragmentation functions.

These problems provide a unifying thread that joins a diverse array of fields, e.g.: few-body nuclear reaction theory; hadron structure and interactions; relativistic heavy-ion collisions; and the physics of heavy-flavour. Following the format and success of the previous workshops held in Huelva and Seville, we will bring together experts in all these areas and provide them with opportunities for open discussions and the inception of new collaborations.

3. Program

The scientific programme will be arranged according to a variety of topics related with the frontier of hadron and particle physics, paying particular attention to those observables that will be most studied in the new generation of experimental facilities, such as the upgraded Jefferson Lab facility (JLab); the Japan Proton Accelerator Research Complex (JPARC); the Facility for Antiproton and Ion Research (FAIR) in Germany; the Nuclotron based Ion Collider facility (NICA), under development in Dubna; experiments at the Large Hadron Collider (LHC); and a possible Electron Ion Collider (EIC), in China or the USA.

The workshop must provide participants with an environment that, through four days of presentations and discussions, fosters interaction and cooperation, with the longer-term aim of either building or reinforcing national and international collaborations.

We therefore plan for the workshop to last Tues. 6-Fri. 9. November, with six invited talks, $45 + 15 = 60$ mins duration each, the first three days:

Morning	–	09:30 - 13:00	(30 min. break at 11:30);
Afternoon	–	16:00 - 19:30	(30 min. break at 18:00);

and a full session on Friday morning. The luncheon break will provide opportunities for detailed discussions of those points raised during the 15 min. question periods.