1^{st} Circular

1. Introduction

This meeting aims to bring together experts in Nuclear, Hadron and Particle Physics in order to facilitate communication, and discern and highlight those features of their common foundation which should provide a means of bridging the gap that separates the fundamental interactions between elementary particles and an explanation of nuclear forces. Namely, to expose the physics hidden in the non-perturbative phenomena of Quantum Chromodynamics (QCD), which 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 has Science been confronted by a theory whose elementary excitations are not those degrees-of-freedom readily accessible via experiment; i.e., whose elementary excitations are *confined*. Moreover, there are numerous reasons to believe that QCD generates forces which are so strong that less-than 2 % of the visible matter in the Universe can be attributed to the so-called current-quark masses that appear in the theory's formulation; viz., forces capable of generating mass from nothing, a phenomenon known as dynamical chiral symmetry breaking (DCSB).

In proposing this meeting, we aim to reinforce and expand the collaborative research teams that were created during the two one-week workshops on "Non-perturbative QCD" that took place in Matalascañas (Huelva) during October 2012 and in Punta Umbría (Huelva) during October 2014. The meeting will enable participants to openly discuss recent progress and novel discoveries in experimental, phenomenological and theoretical aspects of non-perturbative QCD. This is critical to the rapid progress that is necessary in an era when, worldwide, new experimental facilities are being built or entering their commissioning phase. International collaboration in and between experiment and theory is necessary if we are to solve the challenges posed by Nature's most demanding physical theory. Indeed, since physics is ultimately an experimental science, the meeting will place emphasis on comparison with real-world phenomena, which must be the measure of a solution to QCD. With these considerations in mind, selected experimentalists will be amongst the participants. They will highlight the capabilities and discovery potential of current and future facilities, whilst the theorists will present their cases for those quantities whose measurement is most critical.

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. The existence of such states would change forever the concept of "matter," eliminating immediately any further distinction between matter and radiation. However, no theoretical tools exist today that can satisfactorily address these problems, which can only be rigorously posed within the context of non-perturbative relativistic quantum field theory. Notwithstanding this, modern experimental facilities are pushing hard at the frontier of hadron physics, seeking to discover states at which theory can now only hint.

This is unacceptable. Hence, the greatest novelty and the greatest challenge within the Standard Model of Particle Physics is to find essentially new ways and means to predict and explain precisely via mathematics the observable content of 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, there are numerous other problems that must be tackled, given the experimental programmes that are already in place; e.g., the symmetry-preserving computation of hadron elastic and transition form factors, and the computation and parametrisation of parton distribution functions. These problems provide a unifying cord 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 successes of the 2012 and 2014 Workshops, we will gather experts in all these areas and provide them with opportunities for frank discussions and the inception of new collaborations.

3. Program

The scientific programme will be arranged in connection with a variety of physical and theoretical themes related to the frontier of Nuclear, Hadron and Particle Physics, paying particular attention also to planning for and anticipating results from the new generation of facilities, e.g.: the upgraded Jefferson Lab facility (JLab); the Japan Proton Accelerator Research Complex (JPARC); the Facility for Antiproton and Ion Research (FAIR) in Germany; 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 a week of presentations and discussions, fosters interaction and cooperation, with the longer-term aim of building new national and international collaborations.

We therefore plan for the workshop to last five days (Monday to Friday), with six invited talks, each of $45 + 15 = 60$ mins duration, on each of the first four days:

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

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