

# Second International Summer School of the GDR PH-QCD

## Correlations between partons in nucleons

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June 30<sup>th</sup> - July 4<sup>th</sup>, 2014

### 1 Scientific program

Correlations between quarks and gluons in hadrons play a key role in current experiments at low and high energies. Indeed they offer a deep insight into the nucleon structure. They also allow high precision tests of Quantum Chromodynamics (QCD). Last but not least their knowledge is a prerequisite for the phenomenological interpretation of data taken at hadron colliders, for instance concerning the nature and strength of signals of physics beyond the Standard Model.

Tremendous progress has been made in recent years in all fields related to these topics. The aim of this international school is to review these developments, to promote QCD and parton distributions as a unifying concept between apparently distinct lines of research, and to foster contact between the theoretical and experimental communities of particle and nuclear physics.

The guideline of this school is the notion of partonic correlations in nucleons : correlations between quarks and gluons in multiple partons scattering ; correlations between densely packed gluons ; correlations between nucleon spin, parton positions, momenta and spins. Analytical and numerical tools for the evaluation of multi parton scattering have been developed at an increasing level of sophistication and complexity. The school aims at describing these theoretical tools and offering a status and prospective view of the related experimental knowledge.

The first school of this series took place in 2012 and was entitled "QCD prospects for future ep and eA colliders".

### 2 Lectures

Long lectures will be divided into several parts of 1 hour or one hour and a half.

#### 2.1 Long lectures

**6 hours** Partons Distribution Functions and the LHC.

*Introduction to QCD. Partons. Application to the LHC or to an EIC.*

Speaker : M. Stratmann (Brookhaven National Laboratory).

**6 hours** Multi Parton Interactions.

*Space-time, spin and color structure of multiple parton interactions. Elements required for establishing all-order factorization. Constraints on multiparton distributions from general principles and phenomenology, connections with generalized parton distributions, and behavior at small interparton distances.*

Speaker : M. Diehl (DESY).

**4 hours** Nucleon structure.

*Generalized Parton Distributions, Transverse Momentum Dependent parton distributions, Wigner functions. Spin and energy momentum structure.*

Speaker : C. Lorcé (FNRS, IPN Orsay).

**4 hours** Color Glass Condensate.

*The nucleon as a Bose condensate of gluons. Saturation. Phenomenology of the CGC.*

Speaker : R. Venugopalan (Brookhaven National Laboratory and Stony Brook University).

**3 hours** Introduction to event generators physics.

*Monte Carlo event generators, parton showers, multi parton interactions.*

Speaker : L. Lönnblad (Lund University).

**3 hours** The questions of Hadronic physics.

*Quantitative and intuitive understanding of hadron substructure and formation. Ability of existing theoretical tools to describe data. Role of nuclear environment on the partonic structure of the nucleon.*

Speaker : A. Deshpande (Stony Brook University).

## **2.2 Short lectures**

**1.5 hour** CMS and ATLAS signals for MPI processes.

*Hints for MPI signals from ATLAS and CMS.*

Speaker : P. Bartalini (CERN and Central China Normal University).

**1.5 hour** ALICE signals for MPI processes.

*Hints for MPI signals from ALICE.*

Speaker : S. Porteboeuf-Houssais (LPC Clermont Ferrand).

**1.5 hour** Introduction to multi-gluons processes.

*Recent theoretical developments in the computation of scattering amplitudes.*

Speaker : D. Kosower (iPhT, Saclay).

### **3 Student seminars**

There will be five 30 min. slots (one each day) devoted to informal seminars from volunteer students attending the school.