Workshop Report on "Strong QCD from Hadron Structure Experiments"


Victor Mokeev (JLab) for organizing committee.

1. Introduction

The four-day workshop: “Strong QCD from Hadron Structure Experiments”, gathered a select group of 94 hadron-physics world experts and early-career researchers in order to forge the synergistic efforts between the experimentalists, phenomenologists, and theorists in gaining insight into strong QCD underlying the hadron generation from the results on the spectrum and structure of the ground and excited hadrons obtained in the experiments with electromagnetic probes and to initiate the exploration of the atomic nuclear structure emergence from the strong QCD. The successful start of the 12-GeV era of experiments in the four halls at Jefferson Lab in the U.S., as well as the experiments at the European
facilities ELSA, MAMI, and GSI, and the Asian facilities BES, SPring-8, and JPARC, have considerably extended the scope of research in hadron physics. For the first time, these experiments make possible: (a) the mapping of the 1-D and 3-D momentum and spatial distributions of partons within mesons and baryons and the accessing of the components of the hadron energy-momentum tensor in terms of mass, spin, and pressure distributions, (b) exploring the dynamics and impact of hadron mass generation with nucleon elastic, N→N* transitions, and meson elastic/transition form factors and parton distribution amplitudes, and (c) searching for new states of hadronic matter including the so-called hybrid mesons and baryons. Impressive progress in relating the hadron structure observables to the strong QCD mechanisms was achieved from the *ab initio* QCD description of hadron structure to a diverse array of methods in order to expose emergent phenomena via quasi-particle formation. The recent achievements in exploration of the atomic nuclear structure elucidated the driving role of the symplectic group symmetries connecting the nucleon shape emergence from strong QCD to the major features of the structure of atomic nuclei.

The Workshop paves a way to the development of the experiment-phenomenology-theory framework allowing us to gain insight into strong QCD from the aforementioned experimental results on the hadron spectrum and structure, as well as to explore the connection between the atomic nuclear structure and strong QCD. The important part of this Workshop was celebration of outstanding scientific achievements and inspiring leadership in the Hall B program by Dr. V.D. Burkert who was recognized as the Outstanding Scientist of Virginia in 2019.

2. Organization

The workshop took place at Thomas Jefferson National Accelerator Facility, Newport News, USA from November 6 to November 9, 2019.

The local organizing committee consisted of:

Victor Mokeev, Chair (JLab)
Daniel S. Carman (JLab)
Jian-Ping Chen (JLab)
Latifa Elouadrhiri (JLab)
Kyungseon Joo (Univ. of Connecticut)
David G. Richards (JLab)
Craig D. Roberts (Nanjing University)

Full information on the Workshop can be found in:
https://www.jlab.org/conference/QCD2019
3 Budget

The Workshop was supported by:

Jefferson Lab (USA): $5,000
Frankfurt U. (Germany): $1000
University of Connecticut (USA): $1,000
Irfu/SPhN, CEA, Saclay (France): $1,000
Lamar U. (USA): $1000
Ohio U. (USA): $1000

JSA awarded $3,000 that was used to cover travel expenses to USA for young researchers Meriem Ben Ali, Normandie Caen University (France), experimentalist with research activity on the parton distribution studies from DIS experiments and Cerdic Mezrag CEA-Saclay (France), theorist with research activity focused on the development of continuum QCD methods for description of the ground and excited hadron structure.

4 Workshop Summary

The workshop consisted of 42 invited talks. A detailed list of the talks and participants can be found on the workshop web page in the “Agenda” and “Participants List” links, respectively. The Reimei pre-Workshop symposium “Synergies in Hadron Physics between J-PARC and JLab” was organized (Prof. K.Hicks, Ohio U and Prof. K.Joo, UCONN organizers) with the goal of enhancing the connections of research interests being done in the area of hadron physics around the world, and in particular between J-PARC in Japan and Jefferson Lab in the USA.

The workshop canvass a wide range of experiment and theory, e.g.

- Experimental studies of ground-state hadron form factors, inclusive and semi-inclusive structure functions, GPDs and TMDs from exclusive and semi-inclusive meson electroproduction data off protons;
- Excited nucleon structure from exclusive meson electroproduction data and their impact on the exploration of inclusive/semi-inclusive electroproduction;
• Meson spectrum, elastic and transition form factors;
• Search for new states of hadronic matter in the 12-GeV era at JLab;
• Opportunities in the 12-GeV era for charting ground state nucleon structure in three-dimensions;
• Connecting the space-like and time-like amplitudes for electromagnetic transitions from the ground state to excited hadron states over a broad range of $q^2$ spanning across the $q^2$ divide, i.e. from $q^2 < 0$ to $q^2 > 0$;
• Contemporary quark models and their role in understanding strong QCD;
• Refinement of continuum methods in order to provide direct connections between experimental observations and QCD, and to draw insights from experiment into the origin of mass and gluon-quark confinement;
• Prospects for LQCD in the prediction of hadron structure and interactions;
• Development a QCD-rooted, multi-prong theory framework for the unified description of hadron elastic and transition form factors, GPDs, and TMDs;
• Emergence of the intrinsic nucleon and dynamical deformations from strong QCD and their impact on the structure of atomic nuclei;
• Impact of these efforts on expanding the science case for an EIC.

The workshop initiated the development of QCD-rooted multi-prong theoretical framework aimed for relating the experimental results on the structure of the ground and excited hadrons to strong QCD dynamics underlying the ground and excited hadron generation. In order to forge these efforts, the Workshop summary document is under preparation aimed to initiate the new joint research projects between experimentalists, phenomenologists and theorists on exploration of strong QCD from the experimental results on spectrum and structure of the ground, excited hadron and to trace the emergence of the atomic nuclear structure from strong QCD.