2 - 1 Highlights of Nucleon Structure Group*

Liang Yutie and Nucleon Structure Group

Nucleon structure group in QMRC (Quark Matter Research Center) focuses on studies in the field of hadron physics, including both the nucleon structure, and the hadron spectroscopy. Currently, the main goal of the group is to promote the EicC (Electron ion collider in China) project, proposed by IMP. In 2022, the group has achievements in many aspects, including the progress of EicC Detector R&D, and a series of important physics publications.

1 Towards EicC Conceptual Design Report

EicC is proposed based on the HIAF facility[1] by upgrade the proton beam to an energy around 20 GeV, which is made to collide with electrons of the energy of 2.8∼5 GeV. Both beams are polarized and their center-of-mass energy is 10∼20 GeV. The main physics motivations include the precision measurements to the nucleon internal structure in the sea-quark region, the promotion of our understanding of the origin of proton spin and mass, and the study of exotic states.

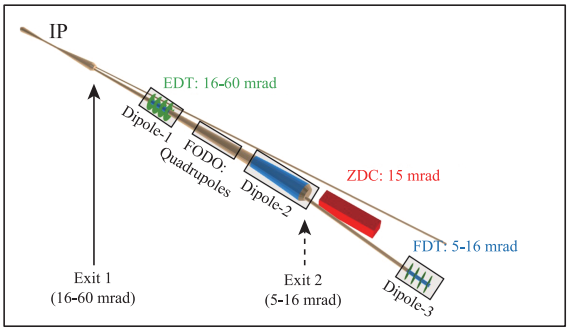

Fig. 1 (color online) First design of EicC forward detector.

After the publication of Whitepaper, the Nucleon Structure Group keeps to push EicC toward the conceptual design report (CDR). Detailed simulations and prototype tests on the detector are being performed. In 2022, one of the main progress on the EicC detector is the first conceptual design of the forward detector, as shown in Fig. 1. Here, the EDT and FDT are two small angle tracking detectors for the forward proton detection and ZDC is a calorimeter for the forward neutron detection. As one of the most important component, the forward detector will be very crucial to the EicC physics programs, such as the study of GPD and exotic states, *etc.* The first draft of the EicC CDR is expected to be finished by the end of 2023.

To better utilize the detector prototypes and optimize the detector design for EicC, a near-future project on the physics of hyperon polarization at HIAF is proposed. Based on a small solenoid with a radius of 11 cm, a small-size detector system with tracking and PID detector can be equipped to measure the polarization of Λ hyperon. This is also to serve as the detector test to bridge the future EicC project.

2 Selection of Physics Publications

In 2022, the Nucleon Structure Group has a series of important publications related to the EicC physics.

In Ref. [2], the periodic oscillation behavior of the proton and neutron form factor is explained. At the leading order of the perturbative expansion, the oscillatory behavior can be naturally produced by the interference between the contribution of nucleon structure and the contribution of vector meson above threshold.

Three-meson $D\bar{D}K$ bound state $K_{c\bar{c}}(4180)$ is predicted by solving the Schrödinger equation with Gaussian expansion method. In this prediction, the $D\bar{D}$ formed a cluster as molecular $X(3720)$ and the K meson is scattered on the D(or $\bar{D}$) in the cluster. It's production in experiments are discussed.

In 2022, the group has made progress on the write-up of EicC CDR, published more than 15 peer-reviewed articles in the field of hadron physics. In the future, the group will continue to push the EicC project, including both the CDR write-up and detector R&D.

References

[1] J. C. Yang, J. W. Xia, G. Q. Xiao, et al. Nucl. Instrum. Meth. B, 317(2013)263.

[2] X. Cao, J. P. Dai, H. Lenske, Phys. Rev. D, 105, 7(2022)L071503.

* Foundation item: Strategic Priority Research Program of Chinese Academy of Sciences (XDB34000000)