Physics at the future eRHIC
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ABSTRACT

An Electron-Ion Collider facility (EIC) [1], a project although known as eRHIC, is under consideration at the Brookhaven National Laboratory (BNL). eRHIC is a machine designed to collimate an electron beam with the currently existing RHIC hadron beam (protons and nuclei), capable of largely varying the center-of-mass energy produced in the collision and the polarization of both beams. The use of a high energy electron beam, the high luminosity of the machine expected in the order of \(10^{34} \text{cm}^{-2}\text{s}^{-1}\) at the highest center-of-mass energy, and the new specifically designed detector, will make eRHIC the ideal “microscope” for investigating, with an unprecedented precision, the three-dimensional picture of the internal structure of the proton. Here I briefly review the most important topics of the broad physics case we aim to carry on at eRHIC and the large impact that such machine can have versus the current knowledge of quarks and gluons (the building blocks of the matter) and thus how they contribute to all the basic properties that characterize a single nucleon, such as mass, charge and spin.

Open questions:

- In a fast moving nucleon the longitudinal size squeezes like in a parton (\(0.02-0.2\) fm)
- What is the polarization of quarks and gluons in the region where they are most abundant?
- What is the flavor decomposition of the polarized sea-quarks?
- What is the role of strong gluon fluids and parton saturation effects in scattering of nuclei?
- What is the space-time and momentum distribution of quarks and gluons in nucleons?
- What is the polarization of gluons in the region of the visible matter in the Universe!
- Unlike LHC, eRHIC will polarize both electron and proton/nuclei beams and will extend of 1000 times the currently available eRHIC range available at fixed target experiments [1], allowing to solve the puzzle!
- Tomography of a nucleon/nucleus in three dimensions
- Understand the properties of gluons, which dominate the mass and density of the visible matter in the Universe!
- What is the spin of the proton spin: solve the ‘spin puzzle’!

Spin physics

- Open question: How do we search for the ‘spin puzzle’?
- In quantum mechanics, spin is the intrinsic angular momentum carried by a particle
- The predicted impact of eRHIC

References


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