

95% of the mass of everything that we can see is made of protons, neutrons and other hadrons which are built out of two types of point-like particles: quarks and gluons, bound by the strong interaction. The interaction is so strong that we can never register a single, free quark or gluon; they always arrive to our detectors in the form of complex structures: pion, kaons, protons, etc. The strong interaction generates 95% of the mass of the visible universe, although gluons themselves are massless and most of the quarks are relatively very light. Because of this remarkable strength of the strong force, quantum phenomena are enhanced and the complicated structure of hadrons is still to be fully understood and appreciated. This is the goal of current and planned experimental facilities, of which either the existing ones, like the experiments at Jefferson Laboratory or at LHC, are being upgraded, or new sites, such as the unique and powerful Electron-Ion Collider are being built. There are several key physical questions that we want to address with these new experiments, for example we would like to have a map of the three-dimensional internal structure and composition of hadrons. Knowing how many and what kind of constituents live inside a hadron, can help us understand how these nearly massless particles form heavy hadrons. Knowing additionally, what is their relative motion with respect to their host hadron, will allow us to understand how is it possible that the motion of all these constituents is coordinated in such a way that the overall spin of the hadron, for instance of the proton, is exactly  $\frac{1}{2}$ . Taken together, this knowledge will translate into the understanding of the dynamics of quarks and gluons inside hadrons, possibly supporting the hypothesis of a new, dense state of gluons known as saturation or color glass condensate, whose existence and properties are a longstanding puzzle. Eventually, we may be able to uncover the mystery and mechanism of confinement, which is required by the fact that free quarks and gluons cannot be observed.

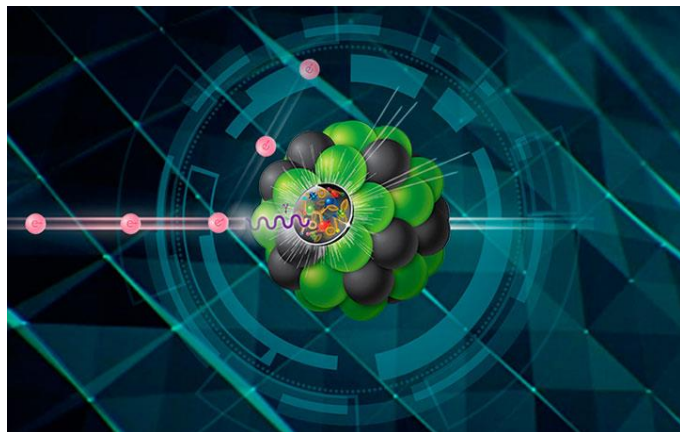


Fig. 1. Electrons will collide with protons or larger atomic nuclei at the Electron-Ion Collider to produce dynamic 3-D snapshots of the building blocks of all visible matter. Electrons are not subject to the strong interaction, therefore provide a clean probe which can scan the interior of the hadron, being it the proton or a more complex ion. Image taken from the EIC website at Brookhaven National Laboratory.

The expected progress on the experimental side requires a similar effort on the theoretical side. Physicists developing the theory of strong interactions as well computational scientists designing new algorithms and computational tools must upgrade their toolbox and increase the precision of their calculations to match the expected excellent quality of experimental measurements. In my group we have developed a unique software which allows to model the gluonic content of protons at high energies with the inclusion of most advanced theoretical corrections. We will employ it to describe the experimental data from experiments at the LHC and prepare predictions for the future facilities such as the Electron-Ion Collider.