From high-energy lepton scattering to nucleon pressure

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Lepton scattering on nucleon is a very nice tool to reveal the structure of the nucleon. In the past elastic scattering and deep inelastic scattering have provided fundamental observables to determine nucleon size or momentum of quarks and gluons inside the nucleon. Nowadays high-energy exclusive experiments are still more challenging aiming to describe more precisely quarks and gluons to measure energy, angular momentum and pressure inside the nucleon. Exclusive reaction means that the final state with the emission for example of a single photon or a meson, is clearly identified. This requires the detection of all the particles in the event with high precision. We will review the exclusive experiments, which have been realized in the world so far and why a new electron-ion collider (EIC) of high energy, high luminosity equipped with a hermetic detector of high resolution can help to achieve this goal.

We will describe the different experimental steps done for the first extraction of the pressure inside the nucleon which has been published in 2018. The pressure distribution inside the nucleon indicated that the central value is about 10 times larger than in neutron stars. This result opens a nice avenue however the experimental method is so demanding that it is worth pursing the effort at EIC.

The three lectures will be (tentatively) organized as follows:

1. Lepton scattering to reveal nucleon structure: elastic scattering, deep inelastic scattering and exclusive reactions. Overview of the exclusive experiments in the past and the future.
2. Observables extracted from exclusive reactions and their interpretation (following the 3rd lecture of Hervé Moutarde).
3. First extraction of the pressure inside the nucleon using Deeply Virtual Compton Scattering (following the 4th lecture of Hervé Moutarde).

References (rather limited and unfortunately not really pedagogic for a non-expert as the topic is still recent):

- Experimental overview of Deeply Virtual Compton Scattering: N. d'Hose, S. Niccolai, A. Rostomyan, Eur.Phys.J.A 52 (2016) 6, 151.
- Experimental overview of Deeply Virtual Meson Production: L. Favart, M. Guidal, T. Horn, P. Kroll, Eur.Phys.J.A 52 (2016) 6, 158.
- The pressure distribution inside the proton: V.D. Burkert, L. Elouadrhiri, F.X. Girod, Nature 557, 396-399 (2018).
- Measurability of pressure inside the proton: K. Kumericki, Nature 570, 7759, E1-E2 (2019)