Home Reading
Nucleon Resonances and Quark Structure

Pages 18–29 of the PDF file, numbered 1152–1163 in the header, sections 5–7 inclusive

Kerim Guseynov
Group 113M
November 6, 2020

Vocabulary

No word was unknown to me. The closest to being unknown was convoluted (section 6.2.2), which I know what means in mathematics (and here) — свёрнутый — but didn't know what means in general context — очень сложный, запутанный.

Questions

1. How can we obtain information about the distribution of s-quark in the proton?
   To obtain such information, one can observe charge-changing reactions with protons and muon neutrinos and search for a pair of oppositely charged muons in the final state.
2. How is the information about PDFs extracted from experimental data?
   High energy deep inelastic scattering experiments provide us with data using which one can calculate an F_2 structure function for the proton. F_2 in its turn can be expressed through PDFs.
3. What carries the proton momentum?
   The proton momentum is carried by particles inside it, but not mainly valence quarks as supposed by a naive picture. It turns out that valence quarks carry about 35%, sea quarks carry 15%, and gluons carry almost 50% of the proton momentum.
4. Are PDFs the same in the nucleus?
   PDFs don't stay intact in the nucleus because of several reasons. First, the nucleus consists of many nucleons, some of which end up being on the surface and some in the center. The latter ones have less access to what happens outside the nucleus. Second, nucleon interactions are carried by pions, which also consist of quarks and hence affect their distributions. And third, nucleons in the nucleus have their own momentum distributions which distort PDFs.
5. What is deeply virtual Compton scattering?
   It is a reaction where a charged lepton is interacting with a nucleon and exchanges a virtual photon with a high Q^2 producing a real photon in the final state.

6. What are the new and proposed facilities to study the nucleon structure?
   New facilities are very expensive to build so most suggestions relate to upgrading the current experimental setups. The upgrades include higher energy electron beams at Jefferson Lab, a new electron ring at RHIC, and a new light ion ring at JLab again.

Main thoughts

Over the past three decades, we were able to develop the idea of parton distribution functions and calculate them to some extent. While we reached an uncontroversial picture describing the proton and its valence quarks, some problems still exist. The first such problem was the proton momentum. However, the gluon contribution was estimated, and scientists managed to incorporate momentum in the quark model. The second problem is the proton spin. According to polarized electron-proton scattering data, only a third of the proton spin is carried by quarks spins. The current gluon and angular momentum data are not enough to solve the issue, and the problem remains open. To investigate it further, new facilities are going to be build and old ones are going to be upgraded.