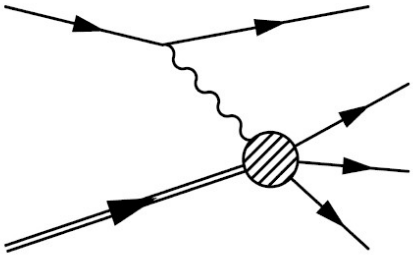
Lecture 5 : Quantum Electrodynamics of Quarks and Hadrons - 2

Inelastic electron-proton scattering :



If the electron has sufficiently high energy the electron-proton scattering becomes inelastic; so the final products could be any hadrons from a rich possibility.

Using the Fermi's Golden Rule for the scattering (with averaging over spins) one may obtain the differential cross section.

Final expression contains the structure functions (or form factors) of the proton.

Examinations of the Figure 8.4, Figure 8.5 and Figure 8.6 from the D.Griffiths textbook "Int. Elem.Particle Physics J.Wiley Pub.

Parton Model

The parton name was proposed by Richard Feynman in 1969.

It is a generic description for any particle constituent within the proton, neutron and other hadrons. Today these particles are known as quarks and gluons (u, c, t, d, s, b, antiquarks and gluons).

Quark Distribution Functions

Valence and sea quarks

The quarks which determine the quantum numbers of hadrons are called valence quarks. In addition to the valence (constituent) quarks hadrons contain virtual quark antiquark pairs which are known as sea quarks. They normally

annihilate each other to form gluons inside the hadrons, however play an important role in deep inelastic scaterings.

One of the central features of QCD is the asymptotic freedom which tells that interactions between partons within a nucleon becomes considerably weakens at shorter distances. This important result was first discovered in 1973 by David Gross, David Politzer and Frank Wilczek (Nobel Prize 2004)

Examinations of the Figure 8.6, Figure 8.7 and Figure 8.8 from the D.Griffiths textbook "Int. Elem.Particle Physics J.Wiley Pub.

Examples of parton distributiun functions

Polarizations (dependence on spin directions)

For a comprehensive treatment :

Particle Data Group Report 2018 Chapter 18 Structure Functions and Parton Distributions Revised August 2019 by E. Aschenauer (BNL), R.S. Thorne (UCL) and R. Yoshida (Jefferson Lab).

Homework and Study Problems :

Examine and try to solve some of the problems listed from the textbook D.Griffiths' "Int. to Elementary Particles"

Solve Problem 8.11

Solve Problem 8.12

Solve Problem 8.13

Solve Problem 8.14

Solve Problem 8.15

Solve Problem 8.16

Solve Problem 8.17