ISSN: 2249-894X Impact Factor :3.8014(UIF) Volume - 6 | Issue - 1 | October - 2016

Review Of Research

CHRONOLOGY OF THE SCATTERING PROCESS

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ABSTRACT:
In order to understand microscopic structure of matter Technique or models proposed got a partial success. This is an effort to study these in chronological order to strengthen the concept of proton spin.

KEYWORDS : *microscopic structure , models proposed , partial success.*

INTRODUCTION :

In order to understand microscopic structure of matter Technique Initially we have to relied on two physical quantities.

1. The spatial distribution of matter (charge or current) in a system, which can be probed through elastic scattering of electrons, photons, neutrons, etc. The observables that one measures are the elastic form (structure) factors, which depend on three-momentum trans-fer to the system. The Fourier transformation of these form factors provides information about spatial distributions.
2. The distribution of constituents in momentum space, or simply the momentum distributions, which can be measured through deep-inelastic scattering (DIS) which is an extension of Rutherford scattering to much higher energies of the scattering particle. Direct evidence for the existence of quarks inside the proton was provided by DIS.

At the lowest order, DIS takes place via the exchange of a virtual photon (γ^*). At very low energy ν or at Q^2 (momentum transfer square in the process) < 1Gev^2 , γ^* scatters off a proton, only the total charge and magnetic moment of the proton apprised and the proton appears to be a point like object.

In order to probe the internal structure of the proton large energy (ν) and momentum (q) transfers are necessary in DIS. There are several functions called structure functions, depending on two variables, Q^2 and ν which expresses the cross section of such scattering. At the start these functions are unknown and they depend on the hadron structure.

These structure functions appeared scale dependent in the early SLAC experimental results (they depend only on the ratio of Q^2 and ν, and do not depend on them separately) that means they show a phenomenon called scaling. Such behavior was explained by Bjorken using the current algebra techniques so-called the Bjorken regime, i.e. when both ν and $Q^2 = -q^2 = \mathbf{q}^2 - \nu^2$ become very large with fixed $x_B = Q^2 /2p \cdot q$ (or $x_B = Q^2 /2M_N \nu$ for a nucleon with mass M_N at rest). In the parton model proposed by Feynman in 1969 (proton consists of point like, massless, non-interacting particles called partons) this phenomenon is interpreted as the incoherent elastic scattering off the partons with the Bjorken x_B being just the fractional (light-cone, longitudinal) momentum of the struck parton. At the parton level one may distinguish three kinds of quark distributions, these are:

- Quark density $q(x_B)$: is the probability of finding a quark with a fraction x_B of the longi-tudinal momentum of the parent (fast-moving) nucleon, regardless of its spin orientation;
- Helicity distribution $\Delta q(x_B)$: gives the net helicity of a quark in a longitudinally polarized nucleon, i.e. it is the

number density of quarks with positive helicity minus the number density of quarks with negative helicity, assuming the parent nucleon to have positive helicity;

• Transversity $\Delta T q(x_B)$: in a transversely polarized nucleon, the transversity $\Delta T q(x_B)$ is the number density of quarks with polarization parallel to that of the nucleon minus the number density of quarks with anti parallel polarization.

The parton model successfully explained scaling of the structure functions. However, later SLAC experiments show scaling violation with the structure functions were found to evolve with Q^2 . This violation of scaling occurs because of the interactions between the constituents of the proton, which are now known as the quarks and gluons. Their interaction is governed by QCD (quantum chromodynamics).

DIS involves diagonal matrix elements of certain operators, thus allowing a probability interpretation in terms of distributions, a full knowledge of the correlations can only be achieved by considering also the non diagonal matrix elements of the same operators. This is possible in exclusive processes under suitable conditions. These non diagonal matrix elements can be parametrized in terms of generalized parton distributions (GPDs). The concept of GPDs introduced in **[1–3]** was originally called skewed parton distributions or off-forward parton distributions. These GPDs are the function of four variables: x define the average light-cone momentum fraction of the struck quark in the intermediate state which is not directly accessible experimentally, ζ the longitudinal momentum fraction of the transfer to the proton, t is the squared momentum transfer,($t = (p - p')^2$, p and p' are the initial and final proton 4-vectors) and finally Q^2 dependence, the scale evolution of the GPDs has been worked out to next-to-leading order of α_s and further **[4, 5]**.

There exists a class of hard processes in which GPDs can be measured and/or constrained. The simplest is called Deeply Virtual Compton Scattering (DVCS). GPDs can also be calculated in QCD using the lattice field theory method, just like ordinary parton distributions. Let us try to give the main lines for DIS and DVCS.

• QCD spin structure of the nucleon usually quantified into three kind of parton distributions:
(1) Forward Parton Distribution Functions (PDFs) (quark and gluon helicity distribution),
(2) GPDs which contain information on the orbital angular momentum of partons, and
(3) Transverse Momentum dependent Distributions (TMDs).

• Measurements of the DIS of leptons and nucleons allow the extraction of PDFs. But PDFs contain neither information on the correlations between parton's intrinsic spin and orbital angular momentum nor on their transverse spatial distribution although they provides detailed knowledge about the distribution of momentum and spin of quarks, anti quarks, and gluons. The momentum probed in this way is the longitudinal momentum of the partons in a fast moving hadron.

• In DIS, we can't get information about the role of the orbital angular momentum of partons in which a proton of total spin ½ . The process $q \rightarrow qg$ of a light quark moving along the z-axis generates orbital angular momentum L_z , since this is the only way for it to conserve the total angular momentum J_z . To access such information we needs quantities that involve transverse momenta, and this can be obtained in the exclusive scattering processes characterize by GPDs.

• DVCS enables to access all four GPD (unpolarized(H, E), polarized($\tilde{H}$, $\tilde{E}$)). It allows the measurement of the detailed momentum and spin structure of proton matrix elements for general squared momentum transfer $t = (P - P')^2$.

• The interference of the amplitudes for virtual Compton scattering and the Bethe-Heitler process leads to an electron-positron asymmetry in the $e^{\pm} p \rightarrow e^{\pm} p\gamma$ cross section which is proportional to the real part of the Compton amplitude. The imaginary part can be accessed through various spin asymmetries **[6]**. DIS measures only the absorptive part of the forward virtual Compton amplitude.

• Unlike the PDFs which at a given scale dependence only on the longitudinal momentum fraction x of the parton, GPDs are functions of three variables, x, ζ and t.

• GPDs depend on the momentum transfer $t = \Delta^2$ between the initial and final hadron, which provides further information on the transverse location of quarks and gluons. Spatial information of hadrons can thus be accessible, where the constancy is determined by Q^2 of the incoming photon.

[1] D. Müller, D. Robaschik, B. Geyer, F. M. Dittes and J. Hořejši, Fortsch. Phys. 42 (1994) 101[hep-ph/9812448].
[2] X. Ji, Phys. Rev. Lett. 78 (1997) 610; X. D. Ji, Phys. Rev. D 55 (1997) 7114.
[3] Radyushkin, Phys. Lett. B 385 (1996) 333.
[4] D. Mueller, Phys. Lett. B 634 (2006) 227.
[5] K. Kumericki, D. Mueller, K. Passek-Kumericki and A. Schafer,Phys. Lett. B 648 (2007) 186.
[6] P. Kroll, Nucl. Phys. A, 598, (1996) 435-461.