CHAPTER - 1

INTRODUCTION
CHAPTER – 1

INTRODUCTION

The modification of hadron properties in the nuclear environment is of fundamental importance in understanding high energy nuclear physics. For the past two decades since the discovery of the European Muon Collaboration (EMC) effect, rapid progress has been made in measurements of the spin averaged EMC effect but still this effect remains a fascinating one. On the other hand, there has been no experimental information on the spin dependence of the EMC effect. One such calculation based on modified Nambu-Jona-Lasinio (NJL) model by Cloet et al. predicts a significant effect. This spin dependent EMC effect emphasizes the quark polarization degrees of freedom within a nucleus, due to the spin-dependence of the coupling between the quarks and the strong field inside the nucleon. Recently, intense theoretical effort has been invested in predicting the EMC effect in polarized structure functions in the moderate to high Bjorken $x$ region.

In this work, a statistical approach based Thermodynamical Bag Model (TBM) is used to obtain Parton Distribution Function (PDF) and then spin independent and spin dependent structure functions of proton and neutron are evaluated. In the convolution model, following the
approach of Akulinichev, the spin averaged structure functions of various nuclear media and also the spin structure functions for nuclear media such as $^7$Li and $^{27}$Al are evaluated. These nuclei are chosen as good choices with a single proton in previous polarized studies. The results of quark spin sums for a proton bound to the nuclear media are compared with that of the theoretical predictions of modified Nambu-Jona-Lasinio (NJL) model by Cloet et al. Thus the central theme of this thesis is an investigation of the in-medium modifications to nucleon structure.

The chapters of the Thesis have been divided into ten. The outlines of contents of forthcoming chapters are as follows:

Chapter TWO deals with general introduction to scattering phenomena and concepts of Deep Inelastic Scattering (DIS). The direct evidence for the existence of quarks inside the proton is provided by deep inelastic scattering. The idea is to accelerate particles to very high energies, and then allow them to interact with a stationary medium, and investigate what happens. Deep inelastic scattering reactions provided the first clear evidence that the quark structure of nucleons and nuclei were significantly different.

Chapter THREE gives a detailed description of the various models of the nucleon such as Quark model, Parton model, MIT bag model, Takagi bag model. These important models have been introduced to get a
picture of earlier famous model available and follow up of TBM as a modified form of MIT bag model.

Chapter **FOUR** provides introduction to EMC effect studies. These include multi-quark clusters, dynamical rescaling, nuclear binding in convolution formalism, the pion model and nuclear shadowing. As the present study in the case of polarized EMC, compares the findings with that of the famous NJL model, the outcomes of NJL model are presented which will be useful for easier comparison and better understanding of TBM.

Chapter **FIVE** introduces the major experimental results and the studies of EMC, BCDMS and NMC. This chapter gives the outline of the importance of the effect.

Chapter **SIX** is dedicated to Thermodynamical Bag Model (TBM). It is a phenomenological model proposed to obtain PDFs as a function of temperature and chemical potential. This model yields the PDFs with correct asymptotic behavior and adequately explains the spin dependent and spin independent structure functions. The derivation of expressions for number density of partons and also their energy densities to obtain equations of state of the modified MIT bag, advantages and clarifications of this model form the basis of this chapter.
Chapter **SEVEN** provides the theoretical evaluation of unpolarized EMC effect based on TBM using convolution formalism for nuclear media such as $^9$Be, $^{27}$Al, $^{40}$Ca, $^{56}$Fe, $^{63}$Cu, $^{108}$Ag and $^{197}$Au and compares the results with experimental data of SLAC E-139. The convolution mechanism that takes into account the momentum distribution function and nucleon structure function following Fermi gas model, adequately explains the unpolarized (spin averaged) structure function ratio studies from light to heavy nuclei.

Chapter **EIGHT** presents the theoretical evaluation of polarized EMC effect. Here for spin dependent structure functions, Carlitz-Kaur model evaluations are used. The spin dependent distribution functions are defined in terms spin averaged distribution functions. The results are compared with theoretical predictions of modified NJL model by Cloet *et al.* that prove significance of this study.

Chapter **NINE** deals the evaluation of EMC effect with spin parameter. The concept of introducing a spin parameter is new and hence number conservation in proton, momentum distribution studies are done to account for the significance of this study. The distribution functions of quarks in nuclear media are then evaluated. The results are compared with theoretical predictions of modified NJL model. Evaluation of quark
spin sums and axial coupling in nuclear media prove the significance of this study.

Finally Chapter TEN as conclusion part summarizes the essential results of statistical PDFs in nuclear media using the phenomenological thermodynamical bag model and also explores the scope for further studies and future prospects.