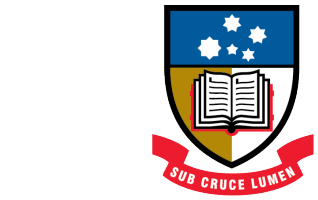
Hadron Structure in Deep Inelastic Scattering



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I would like to dedicate this thesis to my loving wife, Andrea, and
my precious daughter, Georgina ...

Abstract

Deep inelastic scattering (DIS) is an experimental process used to probe a wide variety of properties of hadronic matter. It is a process in which leptons collide with hadrons at high energies, resulting in the hadron being broken into a large number of other particles. Information obtained from this process is combined with what is known from studies of the strong force in Quantum Chromodynamics (QCD), to extract details of the hadronic structure. In this thesis, functions that can be extracted from DIS cross sections are discussed including structure functions, parton distribution functions, and fragmentation functions for single hadron and dihadron cases.

This thesis is presented as a portfolio of publications that investigate some of the previously mentioned functions that can be extracted from DIS processes, which includes semi-inclusive deep inelastic scattering (SIDIS). The first paper describes our method for generating the dihadron fragmentation functions (DFFs) within the Nambu–Jona-Lasinio-jet model. These functions describe the probability of detecting two hadrons with particular light-cone momentum fractions. The DFFs for combinations of pions and kaons calculated in the first paper are obtained at the model momentum scale of $Q_0^2 = 0.2$ GeV^2. Several properties of these functions are explored, including how they change if strange quarks are included.

In the second paper, the appropriate evolution equations are applied to the NJL-jet model calculated DFFs to determine the DFFs at a typical experimental scale of $Q^2 = 4$ GeV^2 for combinations of pions and kaons. A comparison with the results of another model at $Q^2 = 109$ GeV^2 are also presented in this paper, with compelling results.

The final paper departs from the DFFs and instead investigates the gluon spin contribution to the spin of the proton, which is extracted from the spin dependent structure function g_1 using renormalization group techniques. An upper bound is suggested at leading order for the value of this contribution, with an estimate of the error calculated as well.

Statement of Originality

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Andrew Casey and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Publications for the Portfolio

Calculating Dihadron Fragmentation Functions in the NJL-jet model

Andrew Casey, Hrayr H. Matevosyan, and Anthony W. Thomas,
Physical Review D, 85,114049, 2012.

Cited as Ref. [1]

Dihadron Fragmentation Functions from the NJL-jet model and their QCD Evolution

Andrew Casey, Ian C. Cloët, Hrayr H. Matevosyan, and Anthony W. Thomas,
Physical Review D, 86, 11401885, 2012.

Cited as Ref. [2]

Gluon Polarization in the Proton

Steven D. Bass, Andrew Casey, and Anthony W. Thomas,
Physical Review C, 83, 038202, 2011.

Cited as Ref. [3]

Signed:

Andrew Casey

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