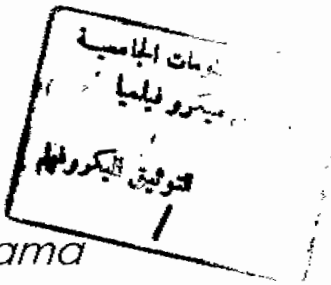
GLAUBER THEORY OF HIGH-ENERGY HADRON-NUCLEON AND HADRON-NUCLEUS SCATTERING WITH QUARK STRUCTURE OF HADRONS

A THESIS

Submitted for the Degree of Doctor of Philosophy in Science (Applied Mathematics)



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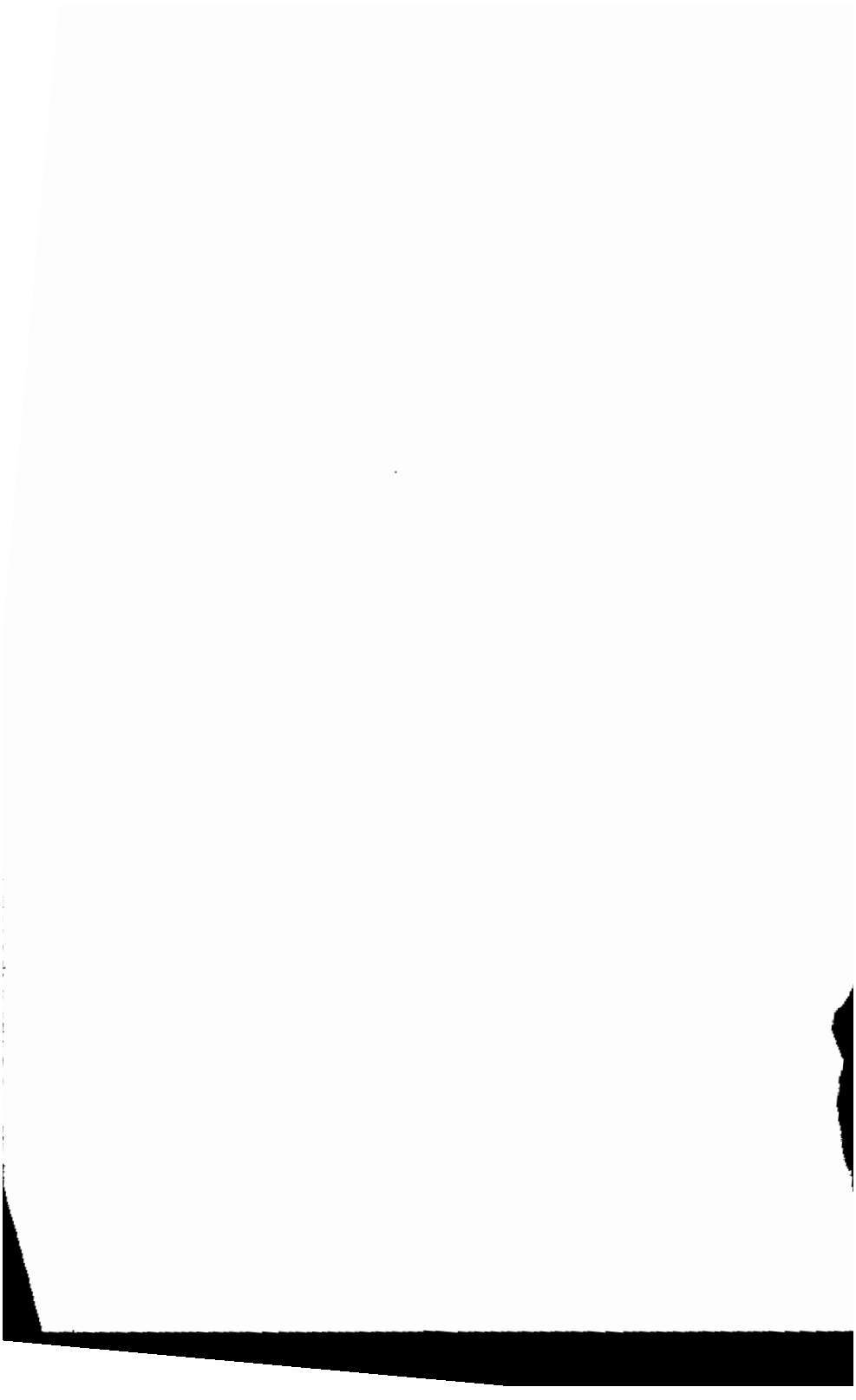

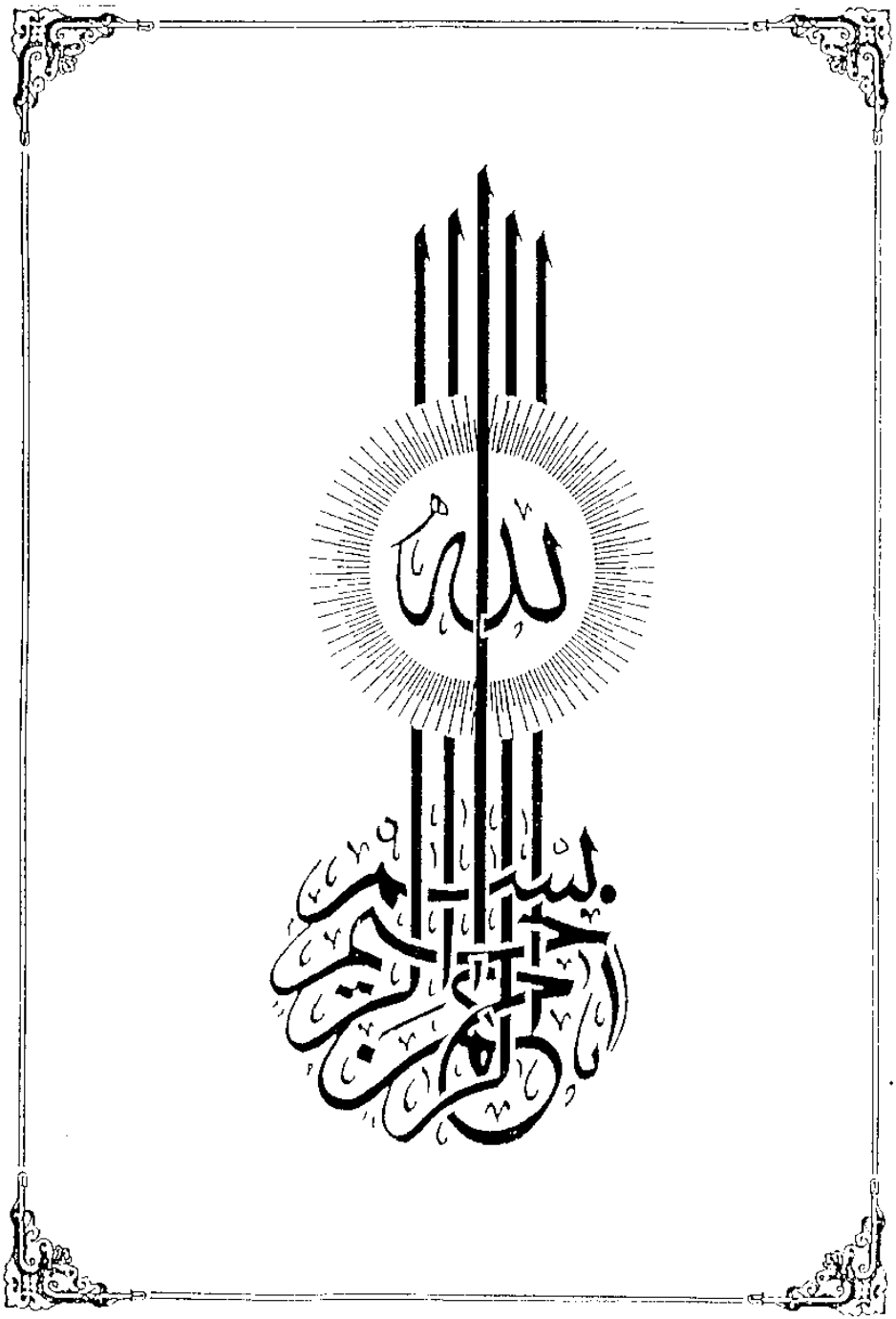

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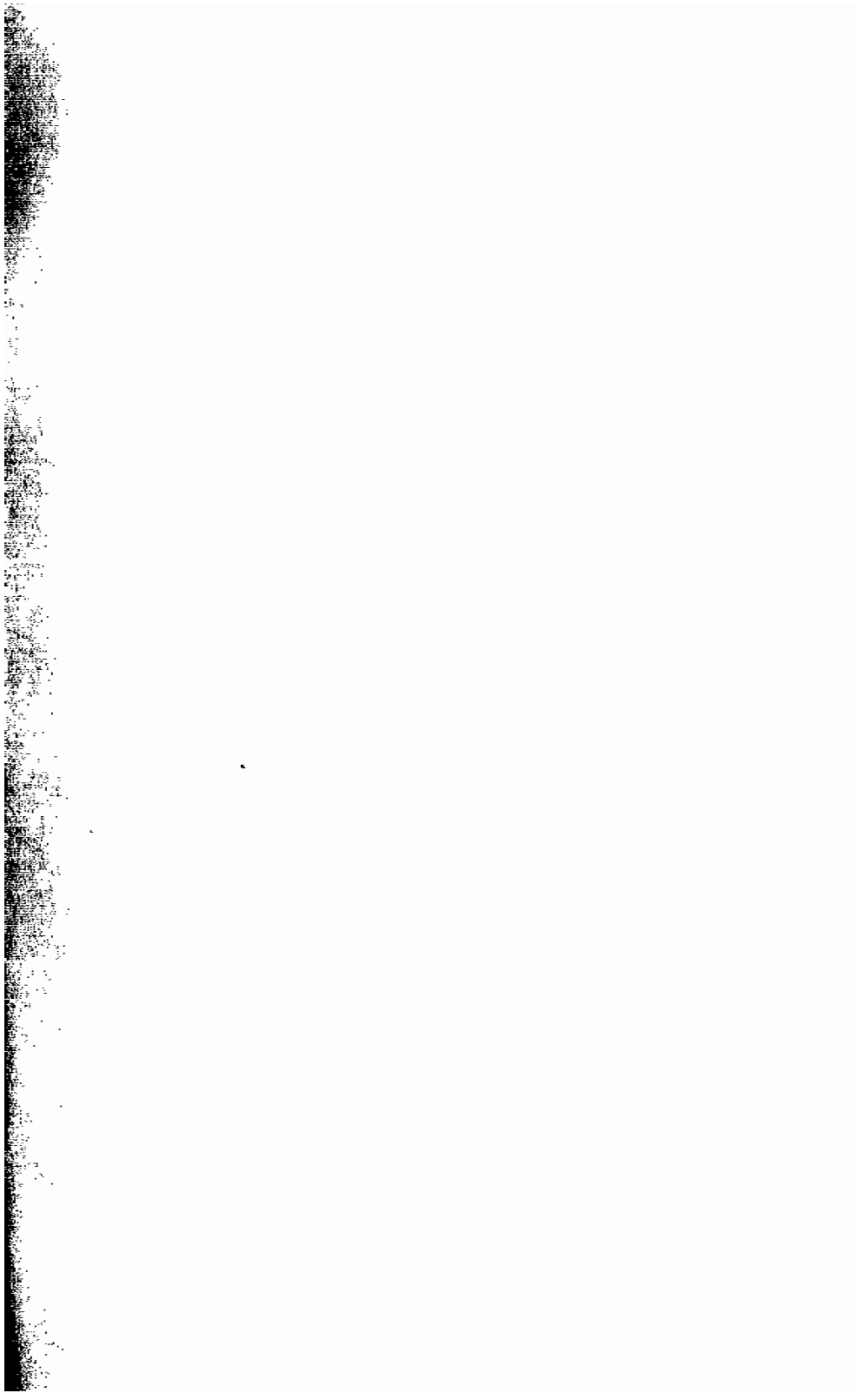
SUMMARY



SUMMARY

This thesis is concerned with the study of two subjects: the first is the short-range correlation between quarks constituting the nucleon and its effect on proton-proton collisions, and the second is the phase variation of quark-quark scattering amplitude and its effect on proton-proton, pion-proton, and proton-deuteron elastic scattering differential cross section. We study the phase variation of quark-quark elastic scattering amplitude using different propositions The first is related to free hadron-free nucleon collision and the second one is assumed to be related to time ordering of the multi-scattering processes. The study is investigated at very high-energy (CERN-ISR range) where the center of mass energy $\sqrt{s}$ lies between 20-60 GeV. At this energy range ($P_{Lab.} = 290 \sim 2000\,GeV/c$) the cross sections are more sensitive to the internal structure of the hadrons. The high-energy multiple scattering theory of Glauber for composite particles is used to calculate the scattering cross sections.

The thesis consists of four chapters as follows:

Chapter I introduces the Gell-Mann quark model and its development where the nucleon consists of three quarks concentrated in the core of the nucleon surrounded by a meson cloud, "cloud of quarks and antiquarks". Also we presented survey of almost all previous literature that used the Glauber approximation to study proton-proton and proton-nucleus collisions at high energies taking the quark model into account. At the end of this chapter we presented briefly the Glauber formalism with the quark structure of colliding particles.

In chapter II, we determined the parameters of quark-quark elastic scattering amplitude A_0, a_0 and α at the used energies where there is no experimental data for these parameters. Then we studied

the quark-quark short-range correlation effect where a proton wave function with some kind of short-range correlation is used to calculate p-p elastic scattering differential cross section in CERN-ISR energy region. We found that the quark-quark short-range correlation in the proton plays an important role at large values of squared momentum transfer. But, a more realistic form for the proton wave function where the quark-quark short-range correlation is considered is needed to obtain a good agreement with the experimental data in the wide range of momentum transfer.

Chapter III, is concerned with the effect of phase variation of quark-quark amplitude on the elastic scattering differential cross section of proton-proton and proton-antiproton at $P_{Lab.}$=15, 290, 500, 1070, 1500 GeV/c and of pion-proton at $P_{Lab.}$=200 GeV/c. We concluded that the phase variation of quark-quark and quark-antiquark scattering amplitude in both used propositions (of Franco and of Hassan et al.) is very important to obtain a good fitness with the experimental data of hadron-proton elastic scattering at low (of order 10 GeV) and high energies. But, Franco proposition plays the major role at low energy for p-p scattering and the Hassan et al., proposition plays the same role at high energies. However, for the pion-proton scattering the Franco proposition gives the essential effect at 200 GeV/c to obtain a good agreement with the experimental data.

Also, we noted that the discrepancy between the experimental data and our theoretical results in the forward direction at high energies for proton-proton and pion-proton scattering is related to pion cloud around the particles

In chapter IV we studied quark-quark phase variation effect on proton-deuteron elastic scattering differential cross section at P_{Lab} = 12.8, 1500 and 2000 GeV/c. The obtained good agreement with the experimental data, explained the importance of the quark-quark phase variation at these energies. A connection between our results and the results based on inelastic intermediate state, which can be

considered as a source of phase variation is established. Also, we concluded that, the asymptotic behaviour of phase variation parameter where $\gamma_{ij} \to 0$ as $E \to \infty$ needs further investigations.

CHAPTER I

INTRODUCTION