A New Look at the Electroweak Interactions of Hadrons

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Abstract. The Standard Model (SM) of elementary particles, in terms of quarks and leptons, is in good agreement with experimental observations. But unlike the leptons, quarks do not exist in free states. They are instead tightly bound in hadrons, which consist of mesons and baryons, which are themselves quark-antiquark states and 3-quark states respectively. Processes involving hadrons are however, complicated. Quarks are subjected to strong forces which are described by quantum chromodynamics (QCD). Because quarks are tightly bound in hadrons by QCD forces, calculations obtained at the quark level cannot be extended, in a straight-forward way, to physical processes involving hadrons. But quarks tightly bound inside hadrons behave like free particles. In this paper we take advantage of this property and formulate a simple model for the effective description of the electroweak interactions of quarks bound in hadrons. We assume that quarks in hadrons are dressed because of the QCD effects, and are represented by their effective dressed masses in electroweak processes. We apply this simple model to the semi-leptonic decays of hadrons, which are described, at the quark level, by the tree level weak interaction. The experiment decay rates are utilized to obtain estimates for the dressed quark masses in hadrons. A reasonable set of values for such dressed masses are obtained.

Keywords: Electroweak interactions, semi-leptonic decays, hadrons.
PACS: 12.15.-y, 12.39.-x, 13.20.-v, 13.30.Ce

INTRODUCTION

The Standard Model (SM) of quarks and leptons is successful in providing good agreement with experimental data. Many of the features of the SM have been well tested. However, although it provides a general framework, it does not offer easy means for calculation when it comes to processes that involve strong interaction effects. Even for electroweak processes, although relatively simple at the quark level, the calculational details become involved and complicated when the processes are folded into the hadronic states. This is because quarks are tightly bound inside hadrons. Because of the non-perturbative nature of such strong forces, there is as yet no agreed and reliable way to describe the interactions of bound quarks in hadrons.

The strong interactions of quarks are described by Quantum Chromodynamics (QCD), which has the property of asymptotic freedom [1-4]. This property of QCD offers a possible treatment for the electroweak interactions of hadrons. Quarks bound inside the hadrons behave as if they are free particles. This allows us to propose a way for treating the electroweak interactions of hadrons. The electroweak processes of hadrons can be described in terms of the corresponding processes at the quark level,

CP1017, *Current Issues of Physics in Malaysia*, edited by H. B. Senin, G. Carini, J. Abdullah, and D. A. Bradley