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STUDY OF GREY PARTICLES IN HIGH-ENERGY HADRON-NUCLEUS AND NEUTRINO-NUCLEUS INTERACTIONS

By

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Abstract

The present work is an inclusive study of the grey particle production in the hadron– nucleus and the charged-current neutrino-nucleus interactions at high incident energies. Grey particles which are mostly protons in the energy range ٣٠-٤٠٠ MeV arise from the intranuclear cascade initiated by the passage of the incident hadron (or the incident neutrino) inside the target. The mathematical procedure proposed here is based on the main assumption that the grey particles are emitted only from the first two generations of the cascade. Higher generations are considered to contribute only to slow evaporated particles (such as protons with energy less than ٣٠ MeV) and therefore they will not be taken into account. This main assumption is introduced in this work in order to investigate two different aspects in two parts. In part I the production of grey particles in hadron-nucleus interactions

are studied. The incident hadron on its way through the target nucleus is assumed to interact successively with ν target nucleons. After the first collision, it is assumed that an excited hadronic matter is formed. The effect of this excitation is taken into account by varying the hadron-nucleon cross section after the first collision and then calculating the multiplicity, angular and energy distributions of the produced grey particles.

Comparison of these calculations with the various experimental data did not show any significance of the effect of excitation on the elementary hadron-nucleon cross section. Normal hadron–nucleon cross section, after the first collision, gave the best agreement with most of the inclusive data.

In part II the model has been applied to study of the grey particles in the charged-current neutrino-nucleus interactions. The neutrino may interact with a quark in a target nucleon via a weak boson and then disappears. From this single primary interaction, the recoiling nucleon initiates an intranuclear cascade. The resulting quark may re-scatter inside the nucleus, before or after it hadronizes into a meson, depending on the hadronization (or formation) time concept. Such a system (single quark or meson) is referred to as a leading particle system. The multiplicity, angular, and energy distributions of grey particles are calculated (taking into consideration the effect of the leading particle formed after the first collision) and compared with the available data. The results support the propagation of the leading particle system as a quark inside the target nucleus.

CHAPTER (1)

Chapter 1

Introduction

The interactions of high energy hadrons (strongly interacting particles) on nuclei are considered essential in the field of nuclear collisions in many aspects. First, the interactions with nuclear targets offer a useful tool of understanding the strong interactions between hadrons. Also such interactions can provide a speculation to solve the more complicated dynamics of heavy-ion collisions, which may be considered as a superposition of hadron-nucleus (hA) interactions. Second, one may hope to learn about the states of the excited hadronic matter which may be formed in the early stages of the reactions. The dominant interaction mode of high energy hA interactions is an inelastic one and leads to multiple production of hadrons which are mostly pions. Strong interactions have a characteristic time scale, given by the size of the hadrons (R_h ~1 fm). When the incident hadron interacts with one of the A