Rutherford Laboratory

Technical leaflet

B16

A MEASUREMENT OF THE K^-- NUCLEON TOTAL CROSS-SECTIONS IN THE RANGE 0.6 - 2.6 GeV/c.

This experiment is a collaborative effort between members of Cambridge and Birmingham Universities and the Rutherford Laboratory. The experiment measures the total interaction rate (total cross-section) of K^-, K^+, π^+ and π^- mesons with protons and neutrons. It is well known that at certain energies the interaction rate exhibits large peaks, called "resonances", corresponding to the formation of excited states of the proton or neutron. Many of these resonances are known in the interaction of π mesons with nucleons. Theory predicts that they should also be present in the interactions of K^-, but probably not for K^+. In the present experiment, a precision measurement with K^- and π^- mesons is being made over the momentum region of greatest interest, 700 - 2600 MeV/c, in an attempt to find small peaks which have previously escaped detection. A subsequent experiment will repeat the measurement for K^+ and π^+ mesons.

The precision will be approximately $\pm$ 1.0% for K^+ and K^-, and $\pm$ 0.2% for π^+ and π^-.

The particles originate from a target situated in the external proton beam from Nimrod. A short beam line selects particles in a narrow momentum band and focuses these on to the experimental apparatus. The beam line can be tuned to accept any given momentum, in the range of interest, in about one hour.

The focused beam has, in general, a few thousand π^- mesons for every K^- meson. These must be clearly separated before the properties of either meson can be studied and this is achieved electronically with the use of Cerenkov counters. The total cross-sections are obtained by accurately measuring the number of particles removed from the beam in passage through 55 cm. long targets of liquid hydrogen and deuterium. A bank of six scintillation counters known as the "transmission counters" are used to detect the particles that have passed through the target. Each of these counters has a different size detector and the counting rate in each detector is used to calculate the true transmission rate into an infinitesimally small counter. The transmission counters can move on rails along the beam direction to maintain optimum conditions over the required momentum range.

The K^-- proton and π^-- proton total cross-sections are obtained by direct measurement with a target of liquid hydrogen. The K^- and π^-- neutron cross-sections have to be obtained by measuring the transmission through a target of liquid deuterium. Since the nucleus of the deuterium atom consists of a proton and a neutron the required neutron cross-sections can be calculated from the measured deuterium and proton cross-sections.

The walls of the target vessels containing the hydrogen and deuterium contribute to the attenuation of the beam and the transmission through an empty target vessel must also be measured to enable the background effect to be subtracted. The three target vessels, "hydrogen", "deuterium" and "empty" have to be introduced into the beam at each momentum and this can be done remotely to an accuracy of 0.5 mm using a motor driven trolley and rails system.