Rutherford Laboratory
Technical leaflet

K7 EXPERIMENT

SCATTERING OF PI-MESONS AND K-MESONS ON A POLARISED PROTON TARGET

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The aim of this experiment is to investigate the interaction between both pi-mesons and protons and K-mesons and protons in a target in which the spin direction of the protons is known. The method of investigation is to use a beam of pi-mesons (or K-mesons) to bombard a target containing hydrogen and to detect the scattered meson and the recoiling proton from the hydrogen. When this scattering process takes place, various resonant states (elementary particles of very short life) may be produced, depending on the energy of the particles in the beam. The properties of some of these states were obtained from an earlier version of this experiment, which used only a pi-meson beam. In the present experiment more of these states will be investigated, including those produced by K-mesons as well as those from pi-mesons. This work is particularly useful at the present time because of the need to test an important theoretical scheme known as Unitary Symmetry. This scheme is able to correlate the pi-meson and K-meson scattering processes and to classify any resonant states that may be produced. It is important to check these predicitions experimentally.

In many scattering experiments the direction of the proton spin is outside the control of the experimenter and oriented at random so that effects arising from this spin are averaged out. In this experiment the target is a special crystal (chemical formula: $La_2 Mg_3 (NO_3)_{12} .24H_2O$) in which a large fraction of the protons in the water of crystallisation can be oriented parallel to one another. Such a target is said to be polarised. Its use in this experiment means that a major source of ambiguity in the interpretation of the results has been removed.

The polarisation of the protons in the target is only achieved at the expense of considerable complexity. In particular, the experiment must be designed to eliminate the interactions between the beam and all the elements in the crystal except hydrogen because only the interactions with hydrogen carry useful information. In order to do this more than 70 scintillation counters are placed around the target to detect the scattered particles and another 30 counters are placed in the beam itself. The outputs from these counters are fed to a high speed electronic network that has recently been developed by the electronics group of this laboratory. The signals from this network go directly to a PDP5 computer which has been programmed to take into account the position of each counter and to reject the unwanted interactions. The final analysis of the data is carried out on the Atlas computer.

Scintillation counters and the K7 experiment

A scintillation counter consists of three elements - the plastic sheet forming the scintillator itself, the photomultiplier tube and the intermediate light guide.

A particle passing through the scintillator material causes the emission of a flash of light which travels down the light guide to the photomultiplier. Light which may escape is reflected back by the aluminium foil and external light is kept out by the black tape wrapping. Arrival of the light at the photomultiplier cathode sends a few electrons into the central structure of the tube. The electrons are attracted down from one plate to another by the electric fields within, and as each electron striking a plate causes about two more to be emitted the electrons multiply until at the base of the structure a large output pulse appears which is suitable for feeding into the electronic data recording system.

The counters used in this experiment are quite small, mostly $3\frac{1}{2}$ inch x 1 inch scintillators, as some 70 of them are fitted around the polarised proton target in the $3\frac{1}{2}$ inch gap between the magnet coils. The light guides lead out from the counters to the photomultipliers outside the magnet. The photomultipliers are contained in iron tubes to shield them from stray magnetic fields. The output signals from the bases of the photomultipliers travel to the high speed electronic logic circuits in the control room and thence to the PDP5 computer which reduces the data to punched tape format for further analysis by the Atlas computer.