Rutherford Laboratory

Technical leaflet

B 13

Ø1 beam line and experiment

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A considerable advance in our fundamental understanding of the strongly interacting particles has been the success of the symmetry scheme known as SU(3). One of the predictions arising from this theory involves the ratio between the electron positron decay modes of the unstable 'Ø' and 'ω' mesons.

$$\text{i.e. } R = \frac{\omega \rightarrow e^+ + e^-}{\phi \rightarrow e^+ + e^-}$$

An experiment which established the branching ratio for $\omega \rightarrow e^+ + e^-$ to be $\sim 2 \times 10^{-4}$, based on three identified events has already been carried out by this team in 1964/65 at Nimrod.

It is the aim of the present series of experiments to identify and measure the rare decay mode of $\phi \rightarrow e^+ + e^-$. Because the cross-section for producing Ø mesons by negative π-mesons interacting on protons is known to be small it is necessary to carry out the measurement in two parts:

(a) first, the production cross-section for $\pi^- + p \rightarrow \phi^0 + n$ must be conclusively established and measured as accurately as possible.

(b) second, assuming that (a) verifies that Ø's are produced in a sufficiently large number, and after the apparatus has been suitably rearranged, the particular decay mode $\phi \rightarrow e^+ + e^-$ will be looked for.

Part (a) is currently in progress

$$\pi^- + p \rightarrow \phi^0 + n$$
$$\downarrow K^+ + K^-$$

The π^--mesons are produced from a target introduced into the circulating beam of Nimrod at the appropriate time in the acceleration cycle. Several hundred thousand π^--mesons are transported along the Ø1 beam line every machine burst. The system of quadrupole lenses and bending magnets focuses the desired momentum π^--mesons onto the liquid hydrogen target.

The majority of these pions pass through the hydrogen target without interacting; about 4% interact with the protons and a very small number of these interactions produce Ø's.

Scintillation counters and a Cerenkov counter placed around and downstream of the liquid hydrogen target are designed to reject the majority of the unwanted interactions and select mainly $\phi^0 \rightarrow K^+ + K^-$ with an accompanying neutron of the correct velocity. Photographic spark chambers interspaced with lead plates are situated downstream of the target, and these reveal the tracks of the K^+ and K^- particles and enable their directions and ranges to be measured in subsequent scanning and measurement. It will then be possible to construct a "missing mass" plot and measure the Ø cross-section.

It will also be possible to estimate the cross-section using the time of flight of the accompanying neutrons under certain trigger conditions.

Part (b) will consist of taking spark chamber pictures of cascade showers developed by the high energy electrons and positrons from the $\emptyset \rightarrow e^+ + e^-$ decay in lead plate spark chambers, and identifying these events unambiguously against the pion and other backgrounds.