A MEASUREMENT OF THE PANOFSKY RATIO WITH A HIGH-ENERGY PAIR SPECTROMETER

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(presented by A. W. Merrison)

The ratio of the reactions

$$\frac{\pi^- + p \rightarrow n + \pi^\circ \rightarrow n + 2\gamma}{\pi^- + p \rightarrow n + \gamma}$$

resulting from negative pions coming to rest in liquid hydrogen has been remeasured by observing the γ-radiation with a large pair spectrometer.

The pair spectrometer is "180° focusing" and has two banks of five scintillation counters each. The phosphors are blocks of plastic scintillator $1'' \times \frac{1}{2}'' \times 3\frac{1}{2}''$; the $3\frac{1}{2}''$ by $1''$ face being presented to the electrons. Adjacent phosphors are separated only by thin aluminium foil which acts as a light seal. The light is transmitted to photomultipliers outside the magnetic field of the spectrometer by perspex light guides.

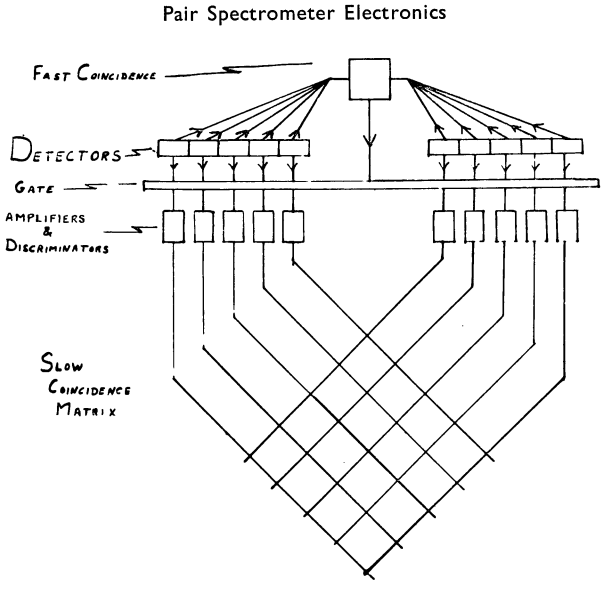

Fig. 1. Simplified block diagram of the electronics.

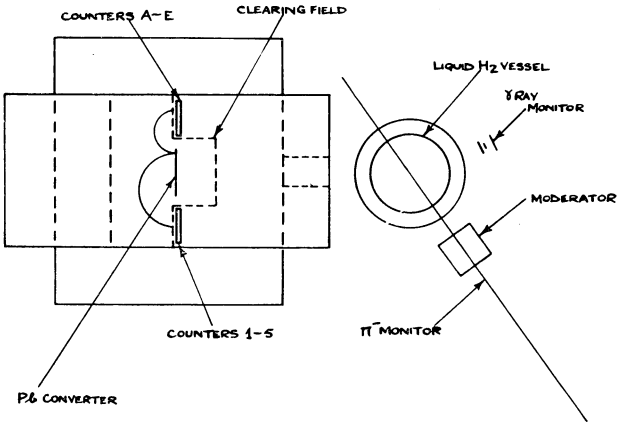

Fig. 2. Experimental arrangement.

A pair is identified by a fast coincidence (20 m μ s) between the two banks of counters, and by pulse height discrimination. The particular pair of counters which has registered the coincidence is then identified and displayed by slow (1 – 10 μ s) electronics.

A simplified block diagram of the electronics is shown in fig. 1. Essentially the two banks of scintillators are linked in a simple fast double coincidence arrangement. If a fast coincidence occurs slow pulses are allowed to go into the counting matrix to show which particular pair of individual scintillation counters are responsible for the coincidence.

The distance between the central phosphors of each bank is 22″, which gives an energy resolution of $4\frac{1}{2}$% (full width at half-height).

The magnet has a maximum field of 15,000 gauss across a $3\frac{1}{2}$ ″ gap. The pole pieces are shaped so that there is a clearing field 9″ long before the γ-rays reach the converter. It is electronically stabilised to better than 0.1% and the field for all magnet settings was measured by a nuclear resonance magnetometer to better than 0.1%.

Experimental arrangement (see fig. 2)

The external negative pion beam of the cyclotron was brought to rest in a large spherical vessel full of liquid hydrogen. The beam was monitored by a small scintillation counter before the polythene moderator, and the γ-rays from stopped mesons were monitored by a scintillation counter telescope.

As the whole of the γ-ray spectrum could not be covered at once, four runs were made; one to cover the high-energy peak and three to cover the low energy distribution. For each run the converter thickness was chosen to give the same R.M.S. scattering angle to ensure the same scattering losses into the pole faces. The thicknesses used in this run were 0.003″ to 0.018″, and each converter was 2″ high and 11″ wide.

For all field settings runs were made with the converter removed to give the background. The ratio of real to background counts in the high peak was 7 : 1 and in the low peak about 3 : 1.

The observed counts have to be corrected for 1) the variation with energy of the sensitivity of the spectrometer, 2) the "weighting" of energy channel (some energies see 5 pairs of counters, some only one) and, 3) the variation in pair production cross-section.

A typical γ-ray spectrum obtained is shown in fig. 3. The γ-rays from the two reactions are well-resolved and the "tail" on the resolution curve, due largely to bremsstrahlung creation in the converter, is clearly shown in the top peak, which results of course from a monochromatic γ-ray line. Our present result for the ratio of mesonic to radiative capture is 1.38 ± 0.20 which includes uncertainties in fitting a resolution curve to the results.

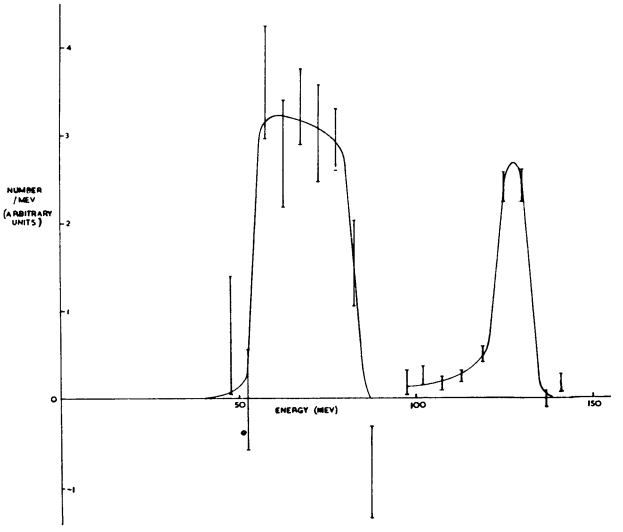

Fig. 3. A typical γ ray spectrum.