Letters to the Editor

Indian J. Phys. **48**. 284–285 (1974)

A preliminary analysis on the ϕ (1020) meson*

P N. UPADHYAY**

Department of Physics, Banaras Hindu University, Varanasi 221005

(*Received* 5 *March* 1973)

An account is presented of a missing mass counter experiment performed to study the production and the decay of the ϕ meson produced in interation

$$\pi\ p \rightarrow \phi n$$

at the beam momenta near its production threshold.

The missing mass of the ϕ meson was calculated by measuring the incident pion momentum and the nucleon time-of-flight. A beam of pion was transported by a quadrupoles and dipoles to a liquid hydrogen target which was 29.4 cm long and 6 cm in diameter. The neutrons were detected by a ring of six identical scintillation counters N_{1-6} placed 6.15 meter downstream of the target. The time-of-flight and hence its four-momentum transfer, t was measured by measuring the neutron time-of-flight between a timing counter placed just upstream of the hydrogen target and the counters N_{1-6}. The time-of-flight zero reference called the fast peak was obtained by the beam pions scattered through small angle in the target. The number of charged particles and the gamma-rays in the final state was determined by an array of counters which surrounded the target. The apparatus and method of operation have been described by Binnie *et al* (1971).

The number of neutron events produced for a fixed number of pion in a specified time-of-flight region called gate is said to be yield. The curve obtained by plotting the yield in a gate as a function of the incident pion momentum is called the yield curve. Just near the production threshold, neutrons go forward in a narrow cone. Hence, the neutrons were detected at laboratory angle near 2.8°. In order to achieve a good mass resolution and maximum collection efficiency of the apparatus which were only obtainable at the incident beam momentum just near the production threshold, a gate of 14 to 17 nsec. after the fast-peak corresponding to $0.18 \leqslant |t| \leqslant 0.22$ (GeV/c)^2 was considered.

The yield curve (without any decay mode selection) has incidated an enhancement near mass 1020 MeV/c^2 which is identified as the ϕ meson (figure 1).

---

* Work done at the Rutherford Laboratory, Chilton, Didcot, Berkshire, U.K.

** Present address : Gaya College, Gaya, Bihar.

The estimated mass of the ϕ meson is in good agreement with previous experiments (Bertanza *et al* 1962, Bellini *et al* 1969, Hyams *et al* 1970). An enhancement in the $\phi \rightarrow \pi^+\pi^-\pi^0$ decay mode was also observed in the yield curve of the some gate (figure 2). No enhancement for the $\pi^+\pi^-$ events in this mass region was observed.

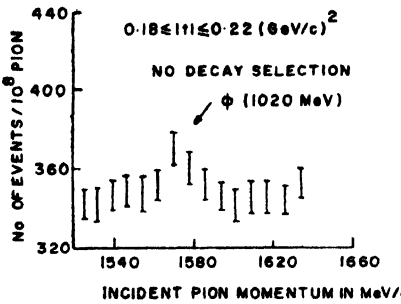

Fig. 1. The yield curve of the neutron events in the gate 14 to 14 nsec. after the fast-peak.

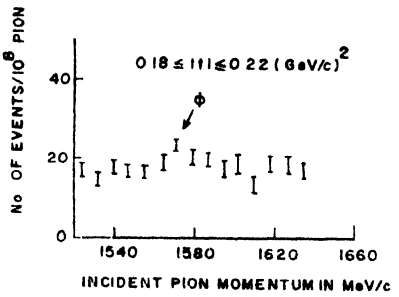

Fig. 2. The yield curve of the $\pi^+\pi^-$ $\gamma\gamma$ events in the gate 14 to 17 nsec. after the fast-peak.

The ϕ meson is well established. Its quantum numbers were determined idependently (Connolly *et al* 1963, Schlein *et al* 1963). The prominent decay modes of the ϕ meson were found to be $K^0{}_1K_2{}^0$ and K^+K^- but not $K_1{}^0K_0{}^0$. The $\phi \rightarrow K_1{}^0K_2{}^0$ decay mode allows odd spin (J), negative parity (P) and negative C-parity and its G-parity is odd. Absence of an enhancement in $\pi^+\pi^-$ decay mode in ϕ region agrees with its G-parity assignment.

References

Bertanza L. *et al* 1962 *Phys. Rev. Lett.* **9**, 180.
Binnie D. M. *et al* 1971 *Phys. Lett.* **36B**, 257.
Bollini D. *et al* 1969 *Nu. Cem.* **60**, 541.
Connolly P. L. *et al* 1963, *Phys. Rev. Lett.* **10**, 371.
Hyams B. D. *et al* 1970, *Nucl. Phys.* **22**, 189.
Schlein P. *et al* 1963, *Phys. Rev. Lett.* **10**, 368,