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LETTERE ALLA REDAZIONE

(La responsabilità scientifica degli scritti inseriti in questa rubrica è completamente lasciata dalla Direzione del periodico ai singoli autori)

Λ^0 Polarization from the Reaction $\gamma+p=K^++\Lambda^0$ in the Energy Range (950÷1050) MeV.

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One of the open problems about the reaction

(1) $$\gamma+p=K^++\Lambda^0$$

at γ-ray energies E_γ near the threshold (910 MeV) is the relative contribution of partial waves of different order. The c.m. angular distribution is known (1) to be isotropic for $E_\gamma \leqslant 1000$ MeV, whereas an increasing anisotropy is observed when E_γ is increased above that energy. As is well known, independent information on this subject can be obtained from measurements of the transverse polarization of the Λ^0 with respect to the production plane. We have performed measurements of the Λ^0 polarization in reaction (1) for the energy range $950 < E_\gamma < 1050$ at the Frascati electron-synchrotron. The measurements are still in progress; preliminary results have already been communicated (2).

The experimental arrangement used is outlined in Fig. 1. The K-mesons are

(1) R. L. Anderson, E. Gabathuler, D. Jones, B. D. McDaniel and A. J. Sadoff: *Phys. Rev. Lett.*, **9**, 131 (1962).

(2) Raccolta delle comunicazioni al congressino annuale dell'INFN, Frascati, Maggio 1963, LNF-63/47, p. 21-25. B. Borgia, M. Grilli, P. Joos, L. Mezzetti, M. Nigro, E. Schiavuta and F. Villa: *Rendiconti della Conferenza Int. di Siena sulle Particelle Elementari* (in press).

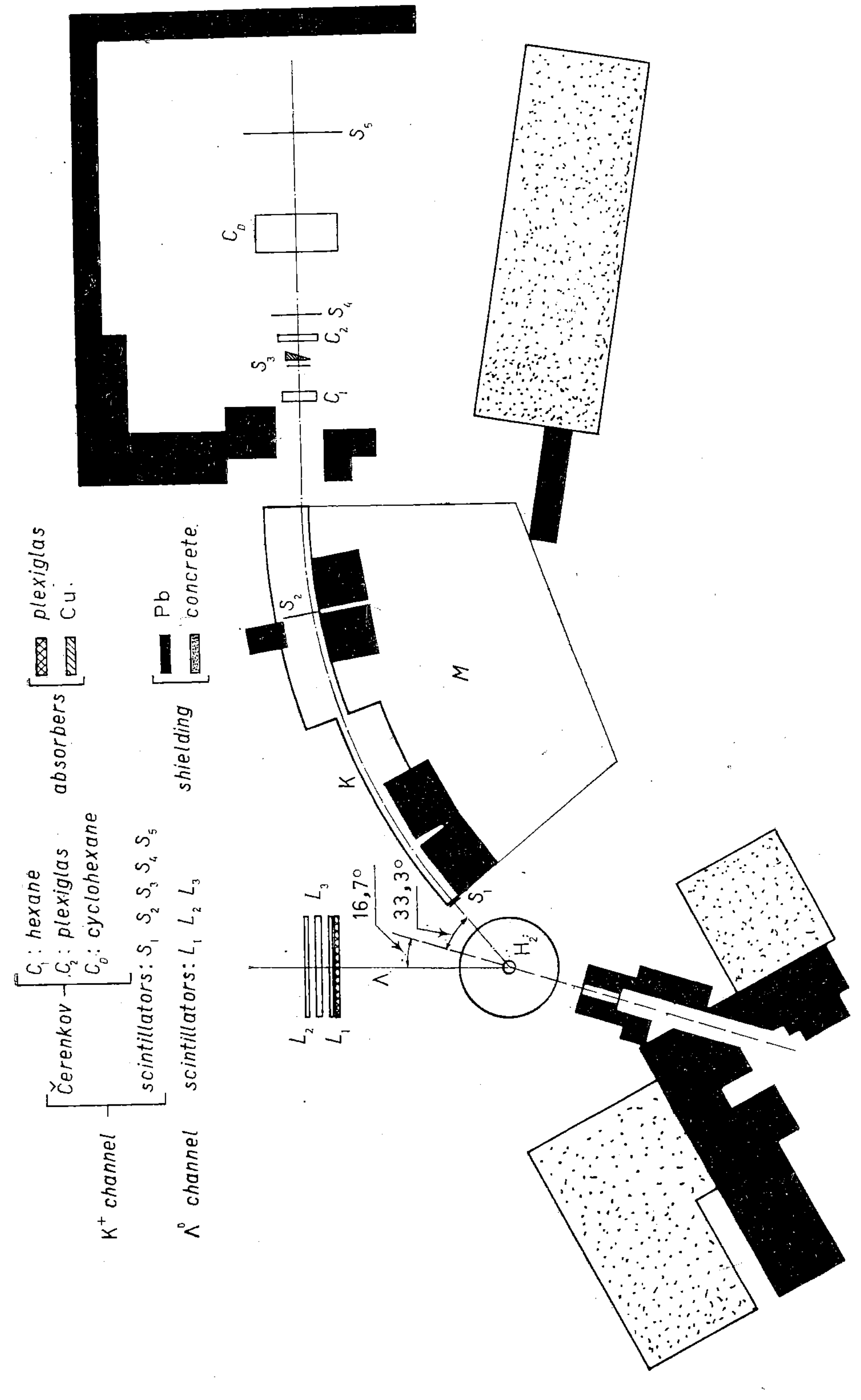

Fig. 1. – Experimental disposition.

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momentum-analysed and identified by means of the deflecting magnet M and of the scintillation (S) and Čerenkov (C) counters $S_1S_2S_3S_4C_1C_2C_DS_5$. The K-mesons of the selected momentum bands are brought to rest in the center of the large liquid Čerenkov counter C_D, where their charged decay secondaries are detected in a 4π geometry. Additional selection criteria are based on the Čerenkov threshold condition in C_1 and C_2, on the measurement of the pulse heights in S_3 and S_4, and on the anticoincidence condition set by S_5.

The signals from counters S_3, S_4 and C_D (as well as those from the counters of the « Λ-telescopes », see later) are displayed on fast oscilloscope traces and photographed by a camera, triggered by a fast coincidence $S_1S_2S_3S_4\bar{C}_1\bar{C}_2\bar{S}_5$. Delays and pulse heights read from the film are digitized and punched on IBM cards and analysed in terms of their correlations with the help of a IBM-1620 computer. Figure 2 shows a typical two-dimensional pulse height distribution of events selected for giving a Čerenkov signal in C_D: the fraction of spurious events inside the K region is evaluated to be less than 3%. This conclusion is confirmed by the shape of the delay distribution of the C_D signals for the « K-events », which is in good agreement with what one expects from the decay of a stopping particle, with the characteristic lifetime of the K^+ disintegration (Fig. 3).

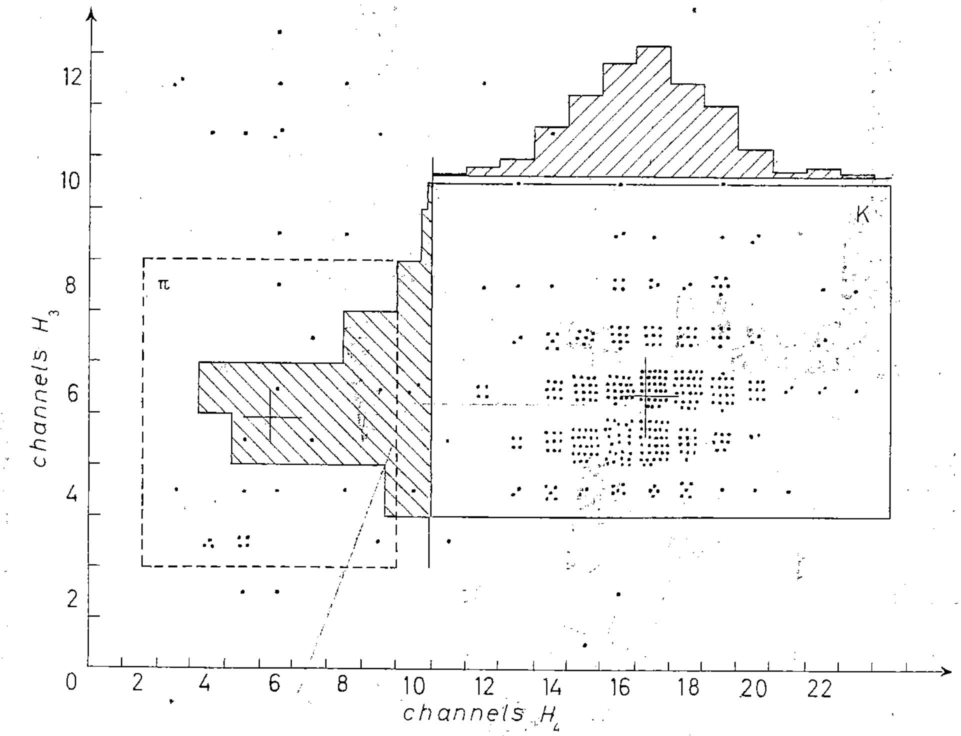

Fig. 2. – An example of two-dimensional pulse-height distribution of events obtained in a « K run » and selected for giving a Čerenkov signal in the decay counter C_D. When the triggering is set to select fast pions (calibration run) 90% of the events are contained in the region enclosed by the dotted line.

The measurement of the Λ^0 polarization is based on the detection of the proton from the $\Lambda^0 \to p + \pi^-$ decay mode, in coincidence with a K-event. The arrangement to detect the proton consists of two identical scintillation counter telescopes (each of three counters

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L_1, L_2, L_3) symmetrically arranged above and below the K-Λ^0 production plane.

What we look for is an up-down asymmetry between the two L telescopes: if N_u, N_d are the numbers of K-events $\alpha=0.62$ [3] is the asymmetry parameter of the Λ^0 decay.

The identification of the decay proton is based essentially on its time coincidence with the K-event.

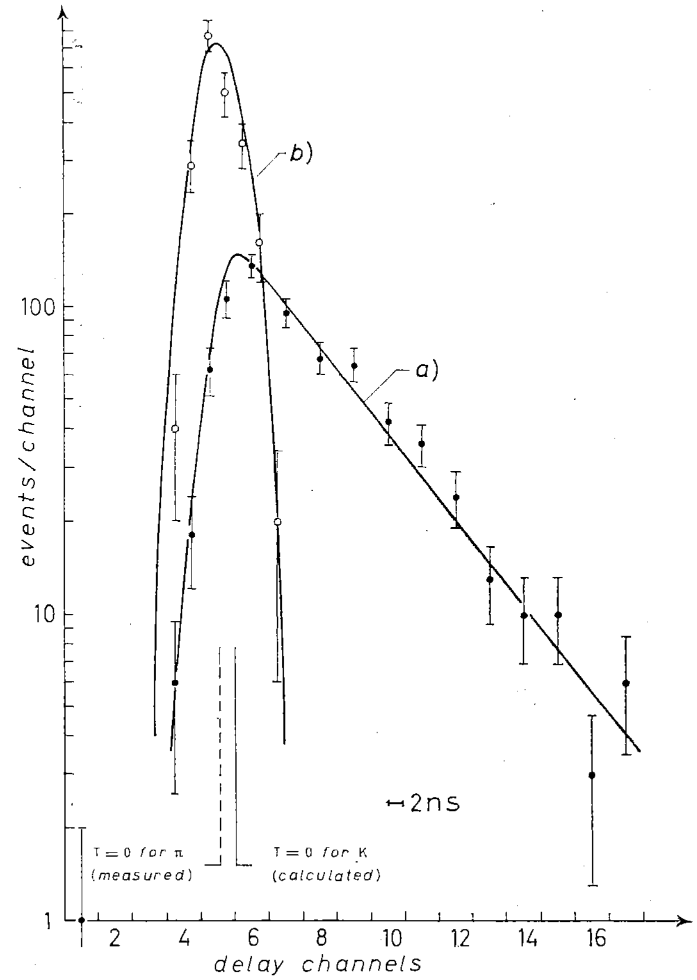

Fig. 3. – Delay distributions of the signals from the decay counter C_D with respect to the telescope signals in a sample of K-events (see Fig. 2) obtained in a «K run» (curve *a*)) and in a sample of π-events obtained in a calibration run (curve *b*)). Curve *a*): $\tau = 12.24$ ns, from ALVAREZ *et al.*, 1956; FITCH and MOTLEY, 1957.

accompanied by a decay proton in the upper or lower telescope, respectively, then the transverse Λ^0 polarization is given by

$$|\alpha P_\Lambda| = G\,\frac{|N_u - N_d|}{N_u + N_d}\,,$$

where G is a constant, depending on the geometry of the L-telescopes, and

The delays of all the signals from the six counters with respect to a reference K counter are read from the oscilloscope traces, in the manner mentioned above, within time gates (of about 100 ns width for each counter) in rough time coincidence with the K-event. The

(3) J. W. CRONIN and O. E. OVERSETH: *Phys. Rev.*, **129**, 1795 (1963).

computer then selects, among all the possible triples of delays from the same telescope, those which correspond to the passage of the same charged particle (*), and calculates, for each of the by the study of the pulse-height distributions in the L-counters.

The results obtained are summarized in Table I. The errors quoted are purely statistical but include the rather

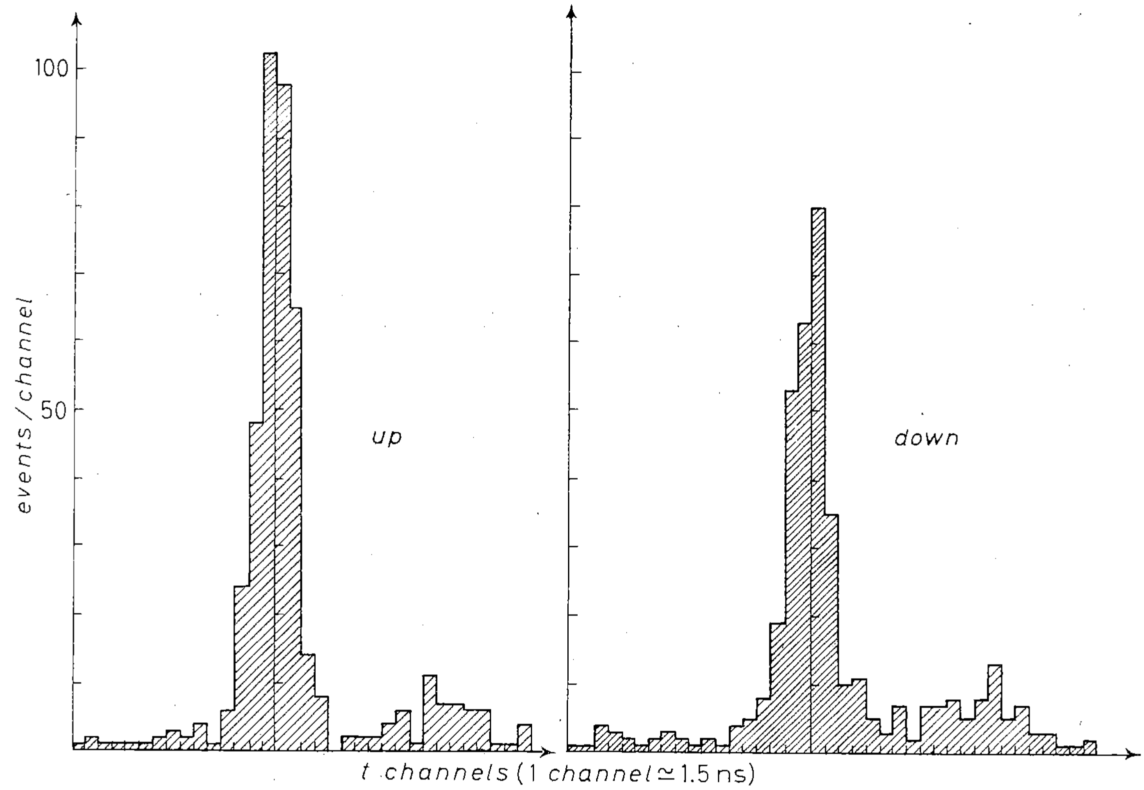

Fig. 4. – Delay distributions of threefold L coincidences with respect to the accompanying K telescope signal.

selected combinations, the mean value t of the three delays. An example of the distributions of t-values obtained in this way is shown in Fig. 4. The main peaks are interpreted as due essentially to true K-Λ coincidences, while the secondary peaks, whose spacing is in agreement with the RF bunching of the synchrotron beam, are used to calculate the chance coincidence background. This interpretation is confirmed

important contribution due to the background subtraction.

Systematic errors might arise from geometrical or detection asymmetries of our system. To minimize their effects, the positions of the two L-telescopes were interchanged systematically every few hours. Moreover, overall symmetry tests have been performed before and after every « polarization run » using the reaction: $\gamma + \text{nucleus} \to p + \pi^- + \text{nucleus}$. The π^- was detected by the magnetic spectrometer, and the proton by the L-telescopes. The choice of the angles and of the magnet current was based on the kinematics of the two-body reaction $\gamma + n \to p + \pi^-$, in such a way as to obtain for the recoil proton, taking into account

(*) In a geometrical representation in a « delay space » t_1, t_2, t_3, these events must belong to a cylindrical distribution around the diagonal of the first octant, with a root mean square radius $\sqrt{3}\,\Delta t$, if $\Delta t_1 = \Delta t_2 = \Delta t_3 = \Delta t$ is the resolution of the individual delay measurements.

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TABLE I.

E_γ (MeV)	θ_K (c.m.)	$\frac{N_u-N_d}{N_u+N_d}$	P_Λ	No. of events
1040±20	86°±6°	0.24±0.09	+0.47±0.18	321
1015±20	94°+7°	0.11±0.08	+0.21±0.16	316
960±10	93°±9°	0.06±0.07	+0.12±0.14	514

also the motion of the nucleus inside the target nucleus, an energy spectrum similar to that of the decay proton of the Λ^0. The asymmetries measured in this way were always compatible with zero and their average amounted to 0.02±0.02.

Figure 5 displays the values of P obtained in the present work, together with those obtained by the Cornell group [4]. The existence of a positive Λ polarization for $E_\gamma > 1000$ MeV appears well extablished; this indicates that partial waves other than S come into play above that energy, in agreement with the behaviour shown by the differential cross-section. The sign of Λ polarization is in disagreement with the predictions of some simple theoretical models [5], which give a negative value of P_Λ.

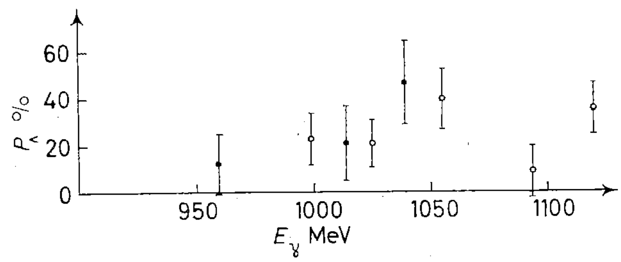

Fig. 5. – The Λ-transverse polarization P_Λ as a function of the incident γ-ray energy E_γ. A positive value means that $\boldsymbol{p}_\Lambda$ is along $\boldsymbol{p}_\gamma \times \boldsymbol{p}$, where $\boldsymbol{p}_{\gamma,\Lambda}$ is the $\gamma(\Lambda)$ momentum in the laboratory system. $\theta_{c.m.} = 80°\div95°$: ○ THOM *et al.* [4]; ● present experiment.

[4] H. THOM, E. GABATHULER, D. JONES, B. D. MCDANIEL and W. M. WOODWARD: *Phys. Rev. Lett.*, **11**, 433 (1963).

[5] T. K. KUO: *Phys. Rev.*, **129**, 2264 (1963); N. A. BEAUCHAMP and W. G. HOLLADAY: *A resonance model for* $\gamma+\mathcal{N}=K^++\Lambda^0$ (preprint).

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