ISTITUTO NAZIONALE DI FISICA NUCLEARE
Laboratori Nazionali di Frascati

LNF-81/42

M. Basile et al. : A MEASUREMENT OF TWO RESONANT CONTRIBUTIONS IN THE Λ_c^+ BRANCHING RATIOS

Estratto da :
Nuovo Cimento 62A, 14 (1981)

Servizio Documentazione
dei Laboratori Nazionali di Frascati
Cas. Postale 13 - Frascati (Roma)

IL NUOVO CIMENTO Vol. 62 A, N. 1 1 Marzo 1981

A Measurement of Two Resonant Contributions in the Λ_c^+ Branching Ratios.

M. Basile, G. Cara Romeo, L. Cifarelli, A. Contin, G. D'Ali, P. Di Cesare, B. Esposito, P. Giusti, T. Massam, F. Palmonari, G. Sartorelli, G. Valenti and A. Zichichi

CERN - Geneva, Switzerland
Istituto di Fisica dell'Università - Bologna, Italia
Istituto di Fisica dell'Università - Perugia, Italia
Istituto Nazionale di Fisica Nucleare - Sezione di Bologna, Italia
Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati, Italia

(ricevuto il 16 Gennaio 1981)

Summary. — The contribution of two resonant states Δ^{++} and $\bar{K}^{*0}$ to the Λ_c^+ decay has been measured. The world average is given.

1. – Introduction.

The purpose of this paper is to report on a study of the contributions to the decay $\Lambda_c^+ \to pK^-\pi^+$ of the two well-known resonant states

$$\bar{K}^{*0} \to K^-\pi^+ \quad \text{and} \quad \Delta^{++} \to p\pi^+ . \tag{1}$$

The experiment has been performed by using, as the Λ_c^+ production reaction, high-energy pp collisions at the CERN Intersecting Storage Rings (ISR). The reaction investigated was

$$pp \to \Lambda_c^+ + e^- + \text{anything}, \tag{2}$$

at a total pp c.m. energy of $\sqrt{s} = 62$ GeV.

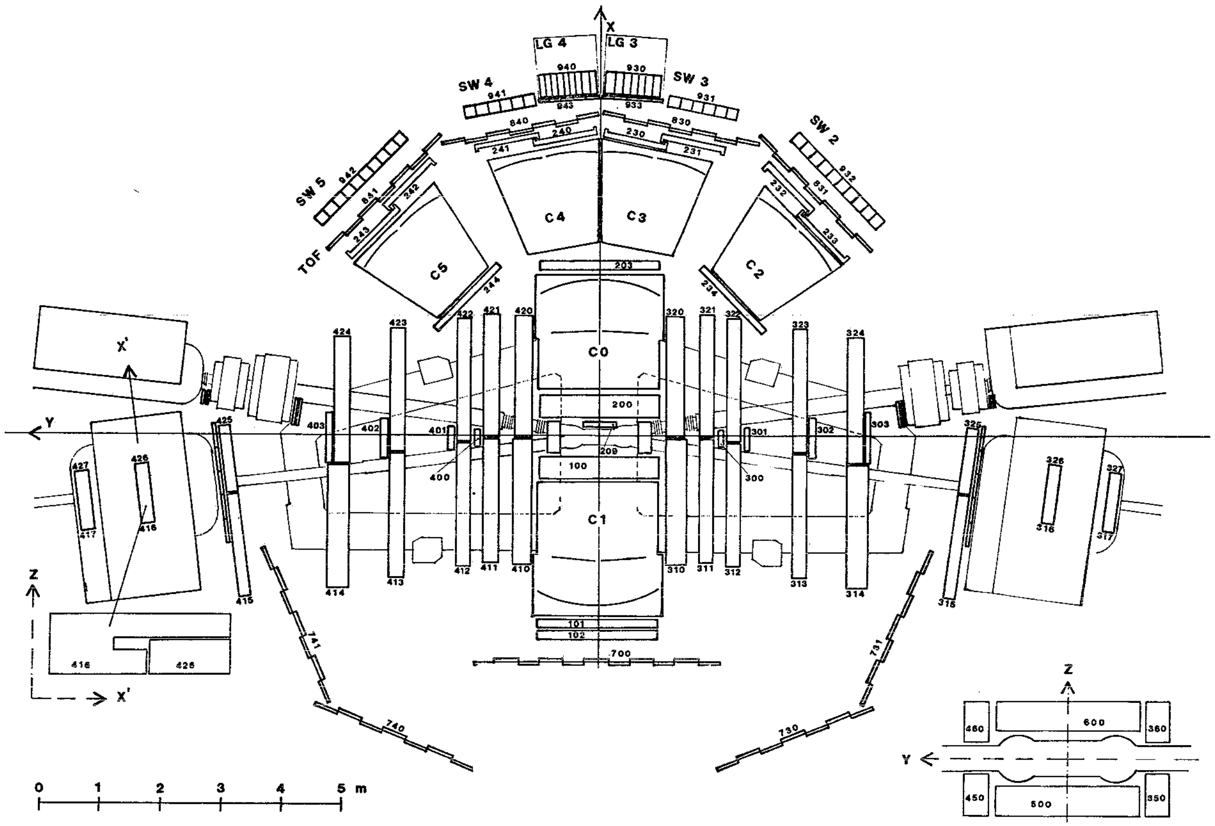

Fig. 1. – Top view of the SFM detector, showing the MWPCs and the external apparatus for particle identification: i) C_i ($i = 0, \dots, 5$) are gas threshold Čerenkov counters, ii) SW_i ($i = 2, \dots, 5$) are lead/scintillator sandwiches, iii) LG_i ($i = 3, 4$) are lead-glass counters. Notice that only coincidences C_0C_3 or C_0C_4 associated to a minimum energy release ($\geqslant 500$ MeV) in the electromagnetic shower detectors (LG_3, SW_3 or LG_4, SW_4) were used in the « electron » trigger.

2. – Experimental set-up.

The experimental set-up consists of a system of multiwire proportional chambers (MWPCs) in a large-volume, 10 kG magnetic field, produced by the Split-Field Magnet (SFM). There are also gas Čerenkov counters and electromagnetic shower detectors for « electron » trigger, plus a large assembly of time-of-flight (TOF) counters for particle identification (p, K, π). Figure 1 shows a schematic lay-out of the set-up, which has been described in detail elsewhere (1).

3. – Data analysis.

From a sample of proton-proton collisions with an electron produced at 90° we obtained (2) a clear signal of the charmed baryon Λ_c^+ decaying via the channel $pK^-\pi^+$.

Firstly, the events were analysed in order to reduce the background contribution to genuine electron events. The contamination from charged hadrons simulating electrons was reduced to the 2 % level. Background electrons from Dalitz π^0 and η decays and from external γ-conversions were rejected to the 50 % level via pulse-height analysis with a dE/dx chamber placed near the intersection region.

From the sample of events left, we selected those with at least one positive particle with $x = 2p_L/\sqrt{s} \geqslant 0.3$ and an error on the measured momentum $\Delta p/p \leqslant 30\,\%$. In these events the positive particle with the highest x has been assumed to be a proton. In the invariant mass, $pK^-\pi^+$, $K^-(\pi^+)$ is any negative (positive) track not identified as an $\bar{p}$ or π^- (p or K^+) by the time of flight. All possible combinations are entered into the mass plot, provided they satisfy the following conditions:

(1) R. Bouclier, R. C. A. Brown, E. Chesi, L. Dumps, H. G. Fischer, P. G. Innocenti, G. Maurin, A. Minten, L. Naumann, F. Piuz and O. Ullaland: *Nucl. Instrum. Methods*, **125**, 19 (1975); M. Basile, G. Cara Romeo, L. Cifarelli, A. Contin, G. D'Ali, P. Giusti, T. Massam, F. Palmonari, G. Sartorelli, G. Valenti and A. Zichichi: *Nucl. Instrum. Methods*, **163**, 93 (1979); M. Basile, G. Cara Romeo, L. Cifarelli, A. Contin, G. D'Ali, P. Di Cesare, B. Esposito, L. Favale, P. Giusti, T. Massam, F. Palmonari, G. Sartorelli, G. Valenti and A. Zichichi: *Nucl. Instrum. Methods*, **179**, 477 (1981); H. Frehse, F. Lapique, M. Panter and F. Piuz: *Nucl. Instrum. Methods*, **156**, 87 (1978); H. Frehse, M. Heiden, M. Panter and F. Piuz: *Nucl. Instrum. Methods*, **156**, 97 (1978).

(2) M. Basile, G. Cara Romeo, L. Cifarelli, A. Contin, G. D'Ali, P. Di Cesare, B. Esposito, P. Giusti, T. Massam, F. Palmonari, G. Sartorelli, G. Valenti and A. Zichichi: submitted to *Nuovo Cimento*.

a) all particles are fitted to the vertex and have a momentum uncertainty $\Delta p/p \leqslant 30\,\%$,

b) both K^- and π^+ are in the same rapidity hemisphere as that of the proton,

c) the rapidity of both the K^- and the π^+ is greater than 1.0.

In order to enhance the Λ_c^+ signal, we have imposed one of the following conditions on the hemisphere opposite to that of the Λ_c^+:

i) either the presence of a leading system of charged particles with $x_{\text{total}} = \sum_{i=1}^{n} x_i \geqslant 0.5$, where $x = 2p_{\text{L}}/\sqrt{s}$;

ii) or a signature for a leading system escaping detection, *i.e.* $x_{\text{total}} \leqslant 0.1$.

The above sum $\sum_{i=1}^{n}$ is extended to all particles fitted to the vertex and with $\Delta p/p \leqslant 30\,\%$. The results are shown in fig. 2.

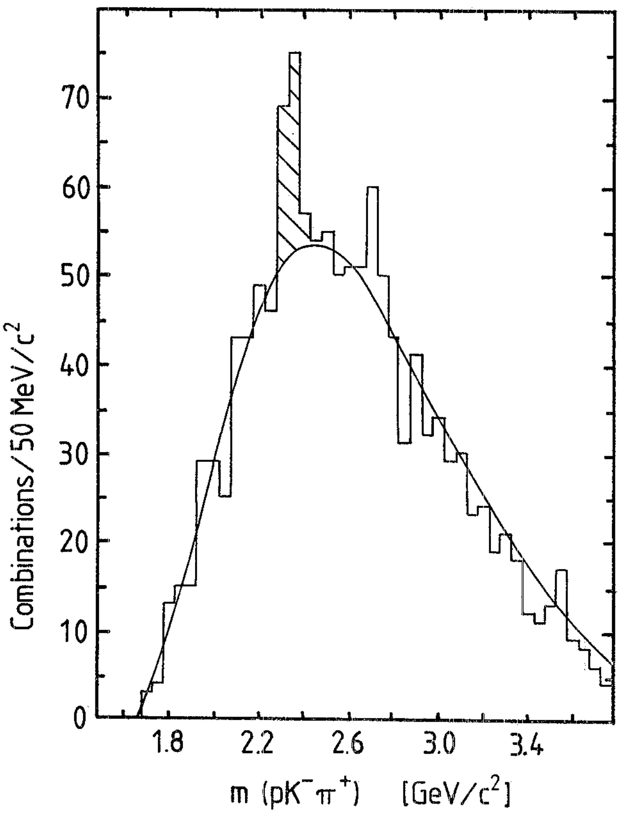

Fig. 2. – Mass distribution of $pK^-\pi^+$ combinations selected as described in the text. The solid line is a fit to the mass spectrum with e^+ trigger. This shape represents the background.

In order to study the resonant contributions to the decay $\Lambda_c^+ \to pK^-\pi^+$ from

$$\Lambda_c^+ \to \overline{K}^{*0}p \quad \text{and} \quad \Lambda_c^+ \to \Delta^{++}K^- ,$$

the mass spectra for $K^-\pi^+$ and $p\pi^+$ have been studied in three different mass ranges for the $pK^-\pi^+$ mass spectrum. These are indicated in table I.

Figure 3 shows the results. Above (fig. 3*a*)) and below (fig. 3*c*)) the Λ_c^+ mass range, the $K^-\pi^+$ and $p\pi^+$ mass spectra do not show any enhancement.

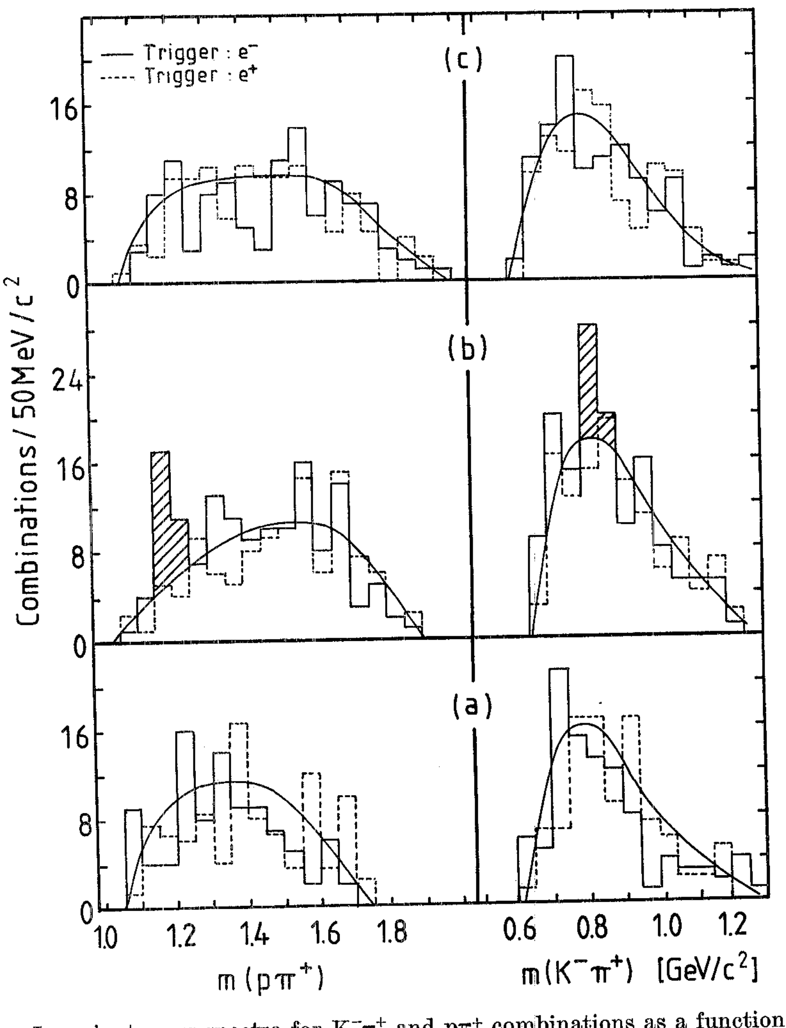

Fig. 3. – Invariant-mass spectra for $K^-\pi^+$ and $p\pi^+$ combinations as a function of three different cuts in the $pK^-\pi^+$ mass: *a*) $2.18 \leqslant m(pK^-\pi^+) < 2.28\ \text{GeV}/c^2$ (below Λ_c^+), *b*) $2.28 \leqslant m(pK^-\pi^+) \leqslant 2.38\ \text{GeV}/c^2$ (in the Λ_c^+ peak), *c*) $2.38 < m(pK^-\pi^+) \leqslant 2.48\ \text{GeV}/c^2$ (above Λ_c^+). The full-line histograms refer to e^- triggers; the dashed-line histograms refer to e^+ triggers. The solid lines are fits to these mass spectra with e^+ triggers.

This is not the case in fig. 3*b*), which corresponds to the Λ_c^+ mass range. Here we observe a peak in the mass spectrum of both the $K^-\pi^+$ and the $p\pi^+$, at mass values corresponding to $\bar{K}^{*0}$ and Δ^{++}, respectively.

TABLE I. – *Mass ranges of* $pK^-\pi^+$ (GeV/c^2).

below Λ_c^+	$2.18 \div 2.28$
in the Λ_c^+ peak	$2.28 \div 2.38$
above Λ_c^+	$2.38 \div 2.48$

Notice that the dashed-line histograms correspond to mass spectra with e^+-triggered events. Here there is no evidence for any resonant state. This is another proof that, in order to have a clean Λ_c^+ signal, the e^- trigger is needed. In fact, the associated production of Λ_c^+ with an anticharmed particle requires the presence of an e^- and not of an e^+. The e^+-triggered events were used to draw the shape of the background in the e^--triggered spectra.

4. – Results.

From the number of events above background in the $\bar{K}^{*0}$ and Δ^{++} peaks and from the total number of observed Λ_c^+, the following branching ratios are obtained:

$$\frac{\Lambda_c^+ \to \bar{K}^{*0}p}{\Lambda_c^+ \to p\,K^-\pi^+} = 0.28 \pm 0.16\,,$$

$$\frac{\Lambda_c^+ \to \Delta^{++}K^-}{\Lambda_c^+ \to pK^-\pi^+} = 0.40 \pm 0.17\,.$$

TABLE II. – *Branching ratios of* $\bar{K}^{*0}$, Δ^{++} *resonant contributions to the* $\Lambda_c^+ \to pK^-\pi^+$ *decay channel.*

		$\bar{K}^{*0}p/pK^-\pi^+$	$\Delta^{++}K^-/pK^-\pi^+$
SPEAR (Mark II) (3)		0.12 ± 0.07	0.17 ± 0.07
ISR (SAJOT) (4)		0.41 ± 0.18	0.53 ± 0.22
ISR (this experiment)		0.28 ± 0.16	0.40 ± 0.17
world average	unweighted	0.27 ± 0.08	0.37 ± 0.10
	weighted	0.18 ± 0.06	0.23 ± 0.06

$$\frac{\Lambda_c^+ \to (\Delta^{++}K^- + \bar{K}^{*0}p)}{\Lambda_c^+ \to pK^-\pi^+} = \begin{cases} 0.64 \pm 0.13 & \text{(unweighted)} \\ 0.41 \pm 0.08 & \text{(weighted)} \end{cases}$$

(3) G. GOLDHABER: *Topical Workshop on the Production of New Particles in Superhigh Energy Collisions* (Madison, Wis., 1979); LBL-10428 (January 1980).
(4) G. SAJOT: Ph. D. Thesis, University of Paris VI (April 1980).

The interest in these measurements is due to the fact that only two results [3,4] are available so far. Table II summarizes the present knowledge of these branching ratios. The world average is also given.

● RIASSUNTO

Analizzando un campione di interazioni protone-protone ad un'energia totale nel centro di massa di 62 GeV, è stata studiata la produzione associata del barione incantato Λ_c^+ con una particella antincantata che decade semileptonicamente. È stato misurato il contributo dei due stati risonanti Δ^{++} e $\bar{K}^{*0}$ al decadimento del Λ_c^+ nel canale $\Lambda_c^+ \to pK^-\pi^+$.

Измерение двух резонансных вкладов в отношения ветвей Λ_c^+.

Резюме (*). — Измеряется вклад двух резонансных состояний Δ^{++} и $\bar{K}^{*0}$ в распад Λ_c^+. Приводится «мировое» среднее.

(*) *Переведено редакцией.*