СООБЩЕНИЯ
ОБЪЕДИНЕННОГО
ИНСТИТУТА
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ
Дубна

E2-5656

V.M.Dubovik, B.L.Markovsky, L.M.Soroko,
T.A.Strizh

ЛАБОРАТОРИЯ ТЕОРЕТИЧЕСКОЙ ФИЗИКИ

ANALYSIS OF THE DOUBLET STRUCTURE OF THE Q-RESONANCE BY FOURIER ALGORITHM

1971

E2-5656

V.M.Dubovik, B.L.Markovsky, L.M.Soroko,
T.A.Strizh

ANALYSIS OF THE DOUBLET STRUCTURE OF THE Q-RESONANCE BY FOURIER ALGORITHM

Дубовик В.М., Марковски Б.Л., Сороко Л.М., Стриж Т.А. E2-5656

Анализ дублетной структуры Q-резонанса с помощью Фурье-алгоритма

Проанализированы заново экспериментальные данные с помощью Фурье-метода. Показано, что Q-резонанс состоит из двух некогерентных компонент с расстоянием между центрами Δ_{cp} = (137±8) Мэв. При некоторых предположениях, выдвинутых ранее, ширины компонент дублета определены.

Сообщения Объединенного института ядерных исследований

Дубна, 1971

Dubovik V.M., Markovsky B.L., Soroko L.M., Strizh T.A. E2-5656

Analysis of the Doublet Structure of the Q -Resonsnce by Fourier Algorithm

The experimental data on Q (1240-1400) are reanalyzed by the method of the Fourier -algorithm. It is shown that the Q - peak results from an incoherent superposition of two components, the distance between their centers being Δ = (137.0 ± 8) MeV. Attempts to extract the Breit-Wigner widths of the doublet components are made.

Communications of the Joint Institute for Nuclear Research.

Dubna, 1971

1.

It seems that up to the present experimenters have no common idea on the structure of the Q-peak (the region of 1240-1400 MeV in the $K\pi\pi$ effective mass spectrum with $J = 1^+$ $I = 1/2$). The results of the investigations on the Q-peak in reaction $K^{\pm} p$ have recently been compiled by Firestone /1/. He used the data available in 20 MeV bins and 10 MeV bins. The Q-peaks were fitted by him to two incoherent Breit-Wigner curves (5 parameter fit) at all energies with reasonable χ^2. His conclusions are the following: the Q - peak consists of two peaks, one with $M = (1250 \pm 4)$ MeV, $\Gamma = (182 \pm 9)$ MeV and the other with $M = (1400 \pm 6)$ MeV, $\Gamma = (220 \pm 14)$ MeV.

Using the Fourier - algorithm we reanalyzed the data from ref. /1/ as well as those in report /2/.

2.

Remind that the method used implies the Fourier transformation of the experimental histogram $f(E)$ and a subsequent analysis of the obtained transform. Further the amplitude $|F(\omega)|$ must be compared with the Fourier transform $G(\omega)$ of the hypothetical resolution curve $g(E)$ of the experimental system employed. If it is assumed that $g(E)$ has a Gauss shape then the high-frequency components appear in the Fourier transform $G(\omega)$ with negligibly small amplitudes, and $|G(\omega)|$ is an envelope of $|F(\omega)|$ unitill noises arise.

The intercept of the curves $|F(\omega)|$ and $|G(\omega)|$ divides the registrated region of frequences into two parts: informational and noninformational.

Now if some resonance has a structure and the noise level is low enough, then we are able to see sequence of minima on the curve $|F(\omega)|$. In the case of incoherent doublet this sequence is:

$$\omega_1 \,,\ 3\omega_1 \,, 5\omega_1 \,, \ldots, (2n-1)\omega_1$$

and for a triplet mixing (Zeeman like splitting)[x]:

$$\omega_2 \,,\ 2\omega_2 \,, 4\omega_2 \,, 5\omega_2 \,, 7\omega_2 , 8\omega_2 \,, \ldots, (3n-2)\omega_2 \,, (3n-1)\omega_2 \,,$$

where

$$\omega_1 = \frac{\pi}{\Delta_d} \,, \quad \omega_2 = \frac{2\pi}{3\Delta_{tr}}$$

and Δ_d , Δ_{tr} are split parameters of the doublet and triplet correspondingly.

3.

Seven histograms from ref. /1/ and two others from /2/ have been reanalyzed using the background curve calculated in /2/ to subtract a background from the experimental histograms /1/. The Fourier transforms of all the histograms have a very pronounced

x) For details see ref. /3/.

first minimum (see for example Fig. 1), located approximately at the same frequency. This fact confirms the existence of a structure in Q-peak. However in every particular case due to poor statistics, we can not fix the multiplicity of the components. But the compilative data with "enriched" statistics /2/ (Fig. 2) indicate for a doublet structure of Q-peak. The position of the second minimum appearing on the Fourier transform (Fig. 3) and (Fig. 4) allows us to conclude that Q is an incoherent mixing of doublet components.

Considering on Fig. 5 and Fig. 6 the behaviuor of $\frac{d\phi}{d\omega}$ (where ϕ is taken from the amplitude showed on the Fig. 3 and Fig. 4) we see that according to some rules obtained in ref. /3/, the doublet consists of two components with intensity ratio $A_1/A_2 = 0.95$. Adopting incoherent doublet mixing the splitting parameters obtained are collected in table 1.

It should be noted that the value of the splitting parameters Δ remains approximately unchanged and equals $\Delta = (137.0 \pm 8.0)$ MeV, irrespective of the absolute experimental resolution specifying the value of ω_{lim}.

4.

We have made attempt to find the Breit-Wigner widths from some histograms collected in ref. /4/. The results of our calculations, which agree with these obtained by the method χ^2, are listed in table II. The resonance widths of the doublet components

Γ_1 and Γ_2 are extracted from the data assuming $\Gamma_1 = \Gamma_2$. This assumption is connected with the fact, that a noise level in every particular experiment gives no possibility of identifying the "long-lived" component, if any. Indeed, in the case of unequal B-W. widths we can extract only the widths of the shortlived doublet component.

5.

We do not know really the instrumental function $g(E)$ and so all predictions of the Fourier method have, as yet, only a preliminary, prognostical power, character to plan further on-line experiments. The method allows to investigate some general properties of the spectrum and to detecte possible splitting of the resonances without any model assumptions.

Thus, in the case under consideration we come to the conclusion that (i) Q peak is an incoherent mixture of two components with splitting between them $\Delta = (137,0 \pm 8.0)$ MeV (ii). It is not obligatory to increase the resolution higher than 10 MeV per bin, because the position of the second minimum on the Fourier transform $|F(\omega)|$ is known too. (iii) In order to obtain with higher confidence the value of splitting parameters and the position of the centers of the components, we need a better statistics: 7000 events or still more (see /2/).

References

1. A. Firestone. UCRL - 19846 Preprint, 1970.
2. B. - Gl. - Oxf. Collaboration "A study of $K\pi\pi$ states produced in 10 GeV/c K^+p interactions". Submitted to the XVth International Conference on High Energy Physics, Kiev, August 26 - September 4, 1970.

3. V.M. Dubovik, B.L. Markovsky, L.M. Soroko, T.A. Strizh. Comm. of the JINR, P1-5340, Dubna (1970) (in Russian).
4. V.M. Dubovik, B.L. Markovsky, L.M. Soroko, T.A. Strizh. Comm. of the JINR, P2-5659 , Dubna (1971) (in Russian).

Received by Publishing Department
on March 3, 1971.

Table I.

	Δ (Mev)	Δ_{lim} (Mev)	$\Delta_{x^2}^{I}$ (Mev)
5,5 Gev/c Hopkins	I5I.0	I02.4	I70.0
I2 Gev/c UCLRL	I35.0	73.2	I46.0
I2 Gev/c UCLRL	I35.0	75.0	-
I2,6 Gev/c Rochester	I5I.0	I02.4	I58.0
compilation 7 Gev/c	I42.0	64.0	I50.0
Io Gev/c Kiev 2 CERN	I28.0	4I.0	I30.0
Illinois 3,2 Gev/c	I35.0	II7.0	I52.0
8,25 Gev/c CERN	I28.0	93.0	-
I0 Gev/c Kiev 2 CERN	I28.0	56.8	I30.0

Table II.

	Γ Fourier(Mev)	$\Gamma_{x}2^{I}$(Mev)	
5,5 Gev/c Hopkins	22I.4	I62±23	255±26
compilation 7 Gev/c	I06.0	I82± 9	220±I4
8.25 Gev/c CERN	II0.8	-	
I0 Gev/c /2/(fig.2)	86.4	I00±I5	I40±I5
I0 Gev/c /2/(fig.3)	96.2	-	

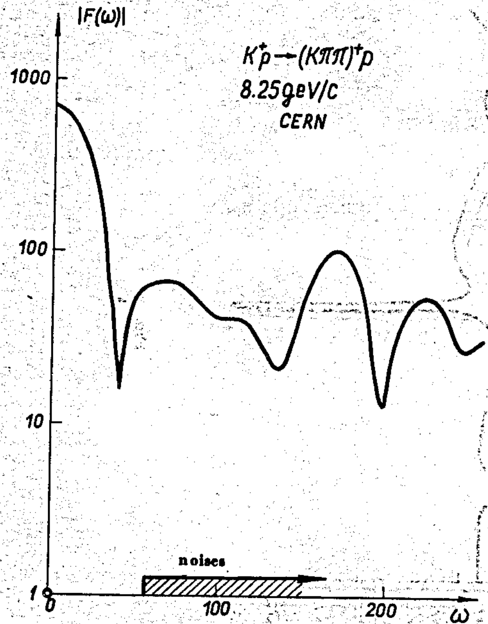


Fig. 1

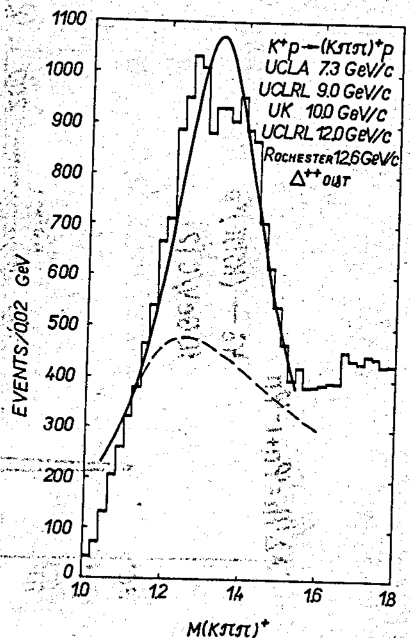


Fig. 2

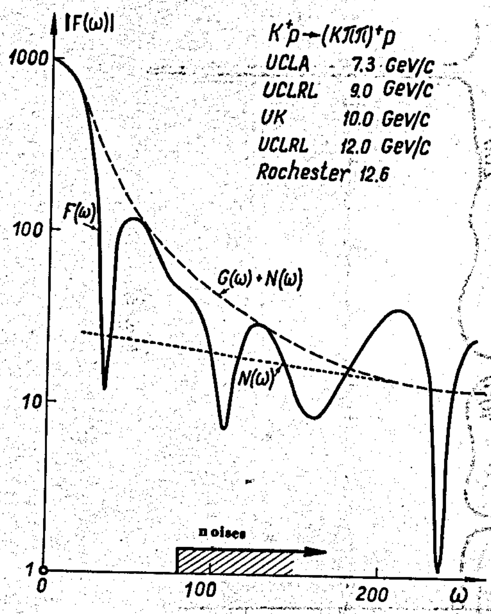


Fig. 3

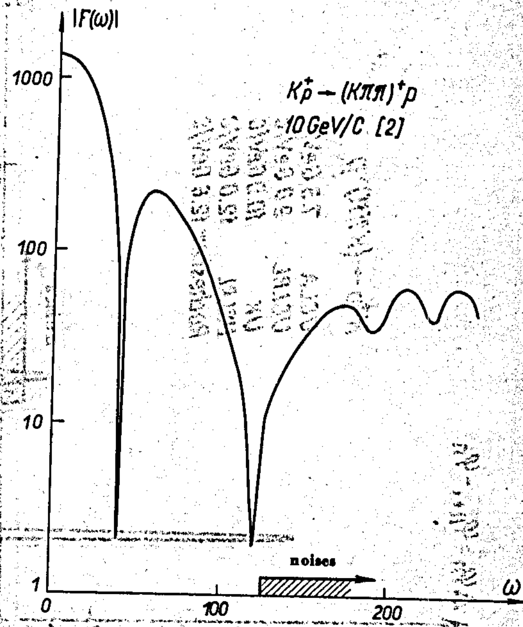
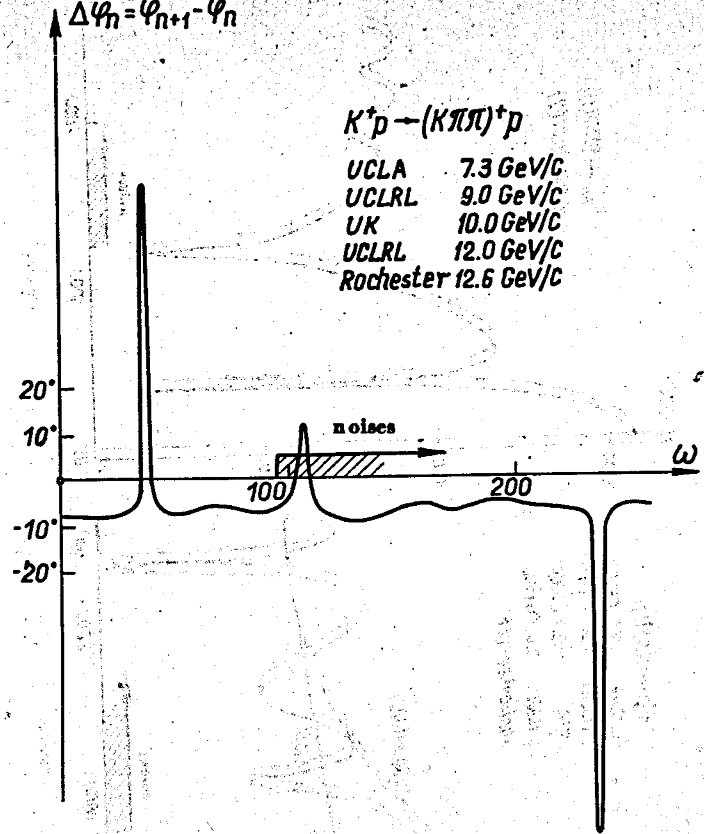
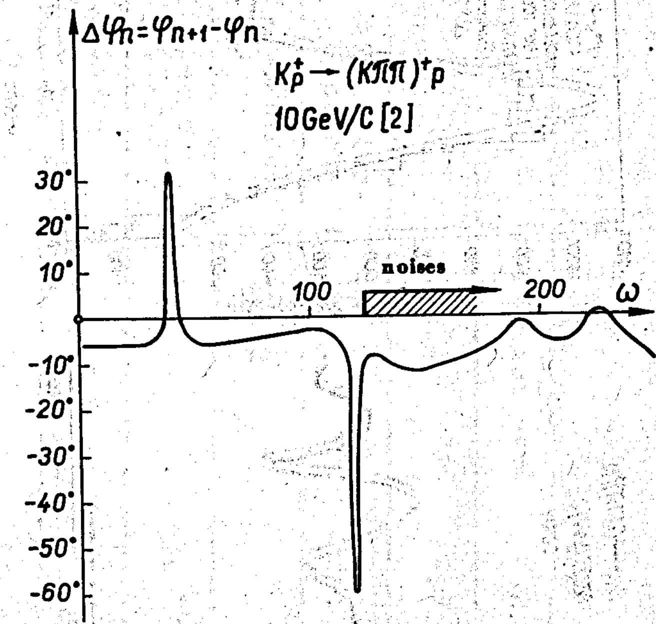


Fig. 4



$\Delta\varphi_n = \varphi_{n+1} - \varphi_n$
$K^+p \to (K\pi\pi)^+p$
UCLA 7.3 GeV/C
UCLRL 9.0 GeV/C
UK 10.0 GeV/C
UCLRL 12.0 GeV/C
Rochester 12.6 GeV/C
20°
10°
-10°
-20°
noises
100
200
ω

Fig. 5.



$\Delta\varphi_n = \varphi_{n+1} - \varphi_n$
$K^+_p \to (K\pi\pi)^+p$
10 GeV/C [2]
30°
20°
10°
-10°
-20°
-30°
-40°
-50°
-60°
noises
100
200
ω

Fig. 6.