SLOW PION PRODUCTION ON LIGHT NUCLEI AND INTERPRETATION OF ABC-ANOMALY AS A RESULT OF ππ-RESONANCE WITH MASS M ≈ 275 MeV

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This work was undertaken in order to search for possible di-pion resonances in the interval $Q \leqslant \mu$, Q being kinetic energy of pions in barycentric di-pion system, μ-pion mass. Experimental data were obtained by means of 17-1

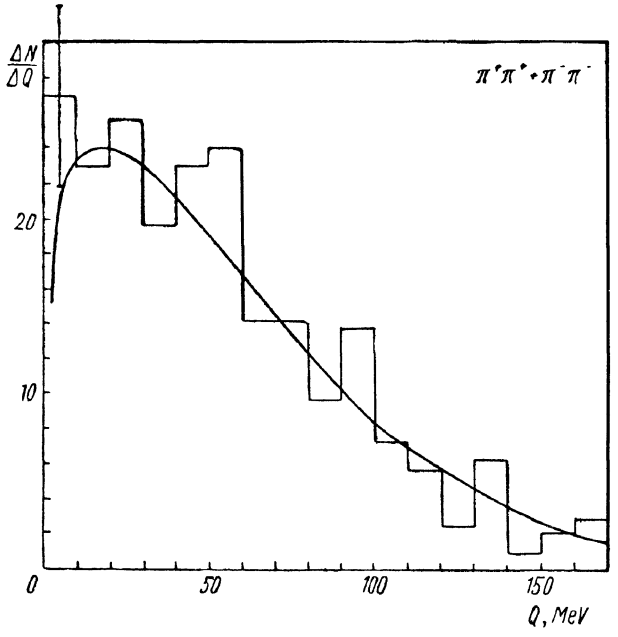

Fig. 1. The Q-distribution for 224 $\pi^+\pi^+$ and $\pi^-\pi^-$ pairs.

and 200-1. ITEP freon bubble chambers, exposed to 2.8 GeV/c π^--meson beams of JINR and ITEP accelerators. While scanning bubble chamber pictures we selected interactions when two or more produced π^+-mesons stopped in the chambers. The Q-value for each pair was determined, mean accuracy being $Q \leqslant 2$ MeV.

The Q-distribution for $\pi^+\pi^+$ and $\pi^-\pi^-$ pairs (Fig. 1) agrees with the theoretical curve $\sigma(Q) = \Phi(Q) \cdot B(Q)$, $\Phi(Q)$ being phase space, $B(Q)$ being Bose-factor.

The Q-distribution for $\pi^+\pi^-$ pairs (Fig. 2) best of all can be explained, if we assume the existence of a narrow 0^{++} pion-pion resonance

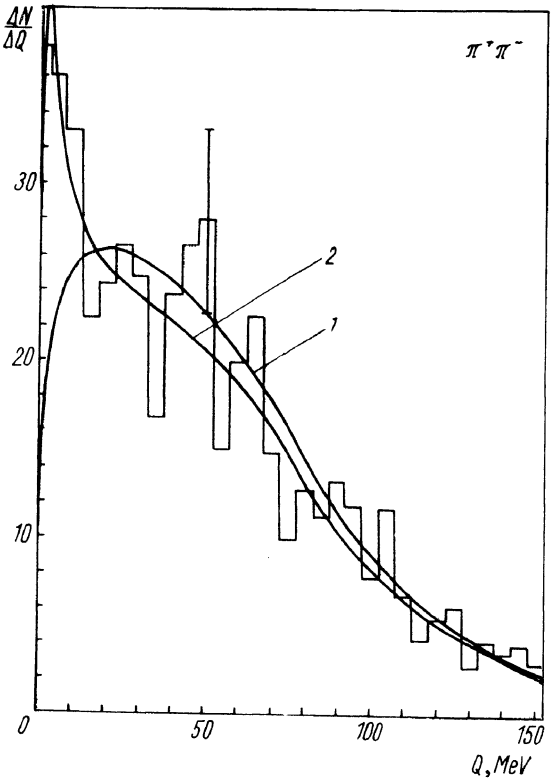

Fig. 2. The Q-distribution for 474 $\pi^+\pi^-$ pairs. Curve *1* — phase space, *2* — best fit curve for φ_0— meson hypothesis $\varepsilon_0 = (-6{,}28 \pm 0{,}98$ MeV; $M = 275$ MeV; $\chi^2 = 17.4$; $(\bar{\chi}^2 = 26)$.

(let us call it φ_1-meson), with mass $270 < M < 279$ MeV. The main effect in the matrix element is given by pion-pion scattering amplitude $a - \gamma/\sqrt{\mu}\,(Q - \varepsilon_0 + i\gamma\sqrt{Q})$. This expression consists of Breit-Wigner term and scattering length $a = (2a_0 + a_2)\,(3 \approx 0{,}5)\,\mu$.

For $\varepsilon_0 < 0$ there is a bound state i. e. the amplitude has a pole at $Q = -\varepsilon$, $\varepsilon > 0$ being a bound energy. This result is a consequence

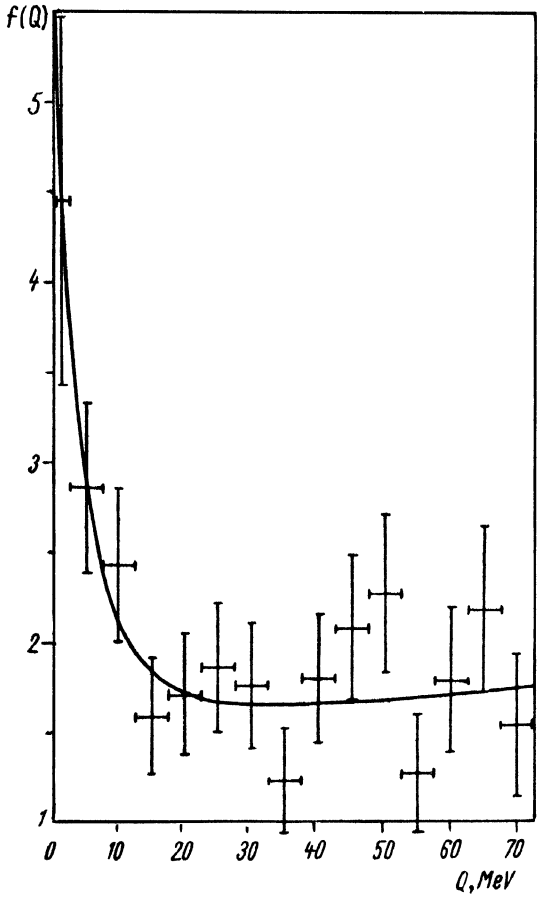

Fig. 3. The distribution of $\pi^+\pi^-$ experimental data for $Q \leqslant 70$ MeV, divided by the phase space, in arbitrary units and the best fit curve according to eq. (1).

of neglecting π^0- and $\pi^\pm$-mass difference (symmetric theory). We neglect energy dependence in other terms of matrix element and take them into account by the substitution $a \to A_k + iB_k$ (A_k and B_k being real constants, k — channel index). The final expression, summed over all exit channels, looks like:

$$f(Q) = \frac{\sigma(Q)}{\Phi(Q)} =$$

$$= C_1 + C_2 \frac{\gamma + 2A\sqrt{\mu}(\varepsilon_0 - Q) + 2B\gamma\sqrt{\mu Q}}{(Q-\varepsilon_0)^2 + \gamma^2 Q}. \quad (1)$$

The trivial constants C_1 and C_2, as well as amplitudes A and B may be varied when passing from one experiment to another. This expression at $B = 0$ was used for an analysis of our data (Fig. 2,3) with a new statistical method [1]. With 99% confidence φ_0-meson mass $272 < M < 276$ MeV. The curves for different values of A fitted to the experimental

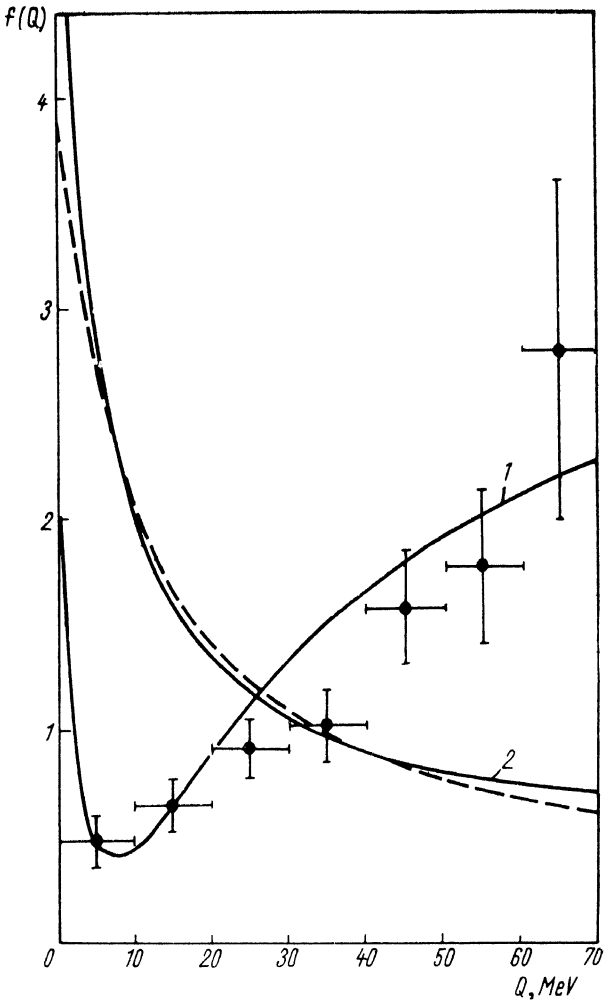

Fig. 4. Curves for the φ_0-meson mass $M = 274$ MeV ($\varepsilon_0 = -10$ MeV; $\gamma^2 = 5$ MeV); 1) $A = 1{,}5/\mu$; $B = 0$; 2) $A = -1{,}0/\mu$; $B = 0$. Experimental points are from [2]. Dotted line is scattering length approximation ($a = 3/\mu$), being used in [3] for fitting their data.

data of Batusov et al. [2] and Abashian et al. [3] are shown in Fig. 4. Inclusion of term $\sim B$ does not change the results.

REFERENCES

1. Samoilov A. V. Preprint PIA of Sc., A-13, 1964.
2. Batusov Yu. A. et al. JETP, 43, 2015 (1962)
3. Abashian A. et al. Phys. Rev., **132**, 2314 (1961).

DISCUSSION

V.S. Barashenkov

I have a query for E.V. Kuznetsov. The explanation of the low-energy $\pi\pi$-anomaly by the existence of a "light" resonance is quite ingenious. However, if this resonon really exists, it must appear in τ-decays. What is your opinion ?

E. V. Kuznetsov

In the data of Bisi et al. (sienna Conference, Bologna, 1963) there is enhancement in the interval $T_{\pi+} - T_{\pi+\max} \leqslant 10$ MeV, but it ought to be investigated in more details.

S.A. Bunyatov

According to Kuznetsov's et al. interpretation of the ABC anomaly, we should observe a strong peak above the phase curve at the spectrum limit in the $\pi^+\pi^-$ mass spectrum of the reaction $\pi^- p \to \pi^+\pi^- n$. In data presented at this conference (Batusov et al.) this peak is not observed up to the 0–5 MeV interval.

V.P. Dzhelepov

We decided to organize additional seminars, in which we can discuss the problem of *NN*- and *N*-interactions in more detail, and then scan the film for a phase analysis in accordance with the suggestion of Prof. V. Moier.