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Φ- MESON MASS DETERMINATION

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Abstract

Using the decay kinematics of the K_s^0 -meson produced in the Φ -meson decay the Φ -meson mass has been determined $m_\Phi = 1020,7 \pm 0,8$ MeV.

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In 1969 the Φ -meson resonance investigation has been performed in Novosibirsk using the electron-positron colliding beams /1/. Three main decay modes of the Φ -meson were detected in the experiment: $K^+ K^-$, $K^0_S K^0_L$, $\pi^+ \pi^- \pi^0$. As the accuracy of the absolute energy determination by means of magnetic measurements was 1 %, the calibration of an energy scale was made using the table value of the Φ -meson mass /2/.

The angular distribution of the detected charged pions produced in the K^0_S -meson decay contains information on its kinetic energy. The maximum non-collinearity angle is unambiguously connected with the K^0_S -meson momentum and using its value one can determine the energy of initial particles as well as Φ -meson mass. The value of the K^0_S -meson mass used is known with a high accuracy, $497,79 \pm 0,15$ MeV /2/. The angular resolution of the spark chamber system is 1^0 . Therefore, we can obtain a good accuracy in the Φ -meson mass measurement.

In the Φ -meson experiment the measurements were performed at 9 values of beam energies. To determine the Φ -meson mass 87 events have been used that corresponded to the process

$$e^+ e^- \rightarrow \Phi \rightarrow K^0_S K^0_L$$
$$\rightarrow \pi^+ \pi^-$$

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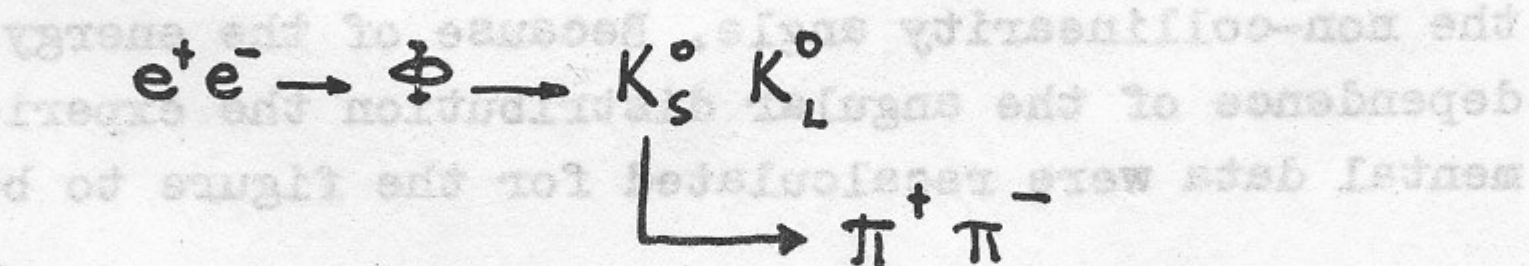
and were obtained at 6 values of the energy in the central part of the resonance peak.

To select this reaction channel the events were chosen with the π-meson range less than 93 g/cm^2. This restriction has been introduced to reduce the background of the process

$$e^+ e^- \longrightarrow \Phi \longrightarrow \pi^+ \pi^- \pi^0$$
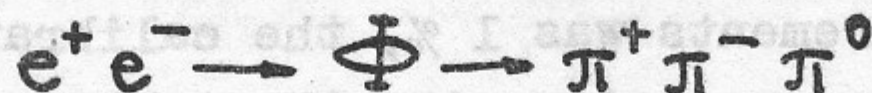
having a more wide interval of accessible non-collinearity angles ω.

The calculation showed that under those restrictions this admixture was about 4 events for the region of angles $10^0 < \omega < 50^0$. Besides that to exclude the events of the process

$$e^+ e^- \longrightarrow \pi^+ \pi^- \gamma$$
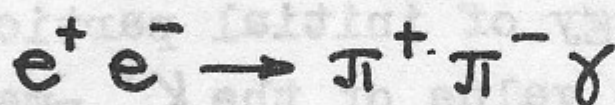
a restriction has been introduced on the azimuth component of the non-collinearity angle $|\Delta\varphi| > 4^0$.

During the background measurements which were performed when the beams had a vertical gap of 2 mm no events satisfying the $K_s^0 K_L^0$-channel selection criteria were detected.

In Fig.1 the experimental and theoretical distributions of events are shown with respect to the non-collinearity angle. Because of the energy dependence of the angular distribution the experimental data were recalculated for the figure to be

clear to the energy corresponding to the Φ resonance maximum. The theoretical distribution shown also corresponds to this energy and it takes into account the radiative corrections /3/, the angular resolution of the spark chambers the background pedestal being included as well. The calculation was performed by the Monte-Carlo method.

The Φ -meson mass was determined by the maximum likelihood method:

$$m_\Phi = 1020,7 \pm 0,8 \text{ MeV}$$

The error quoted takes into account the uncertainty of the Φ -resonance position on the excitation curve ($\pm$ 0,14 MeV) as well as the K^o_s -meson mass error ($\pm$ 0,15 MeV) and possible systematic errors connected with the non-collinearity angle measurements (less than $\pm$ 0,3 MeV). The table value

$$m_\Phi = 1019,5 \pm 0,6 \text{ MeV} \quad /2/$$

R e f e r e n c e s

1. V.E.Balakin et al, Phys. Letters, 34B, 328(1971).

2. Particle Data Group, April, 1971.

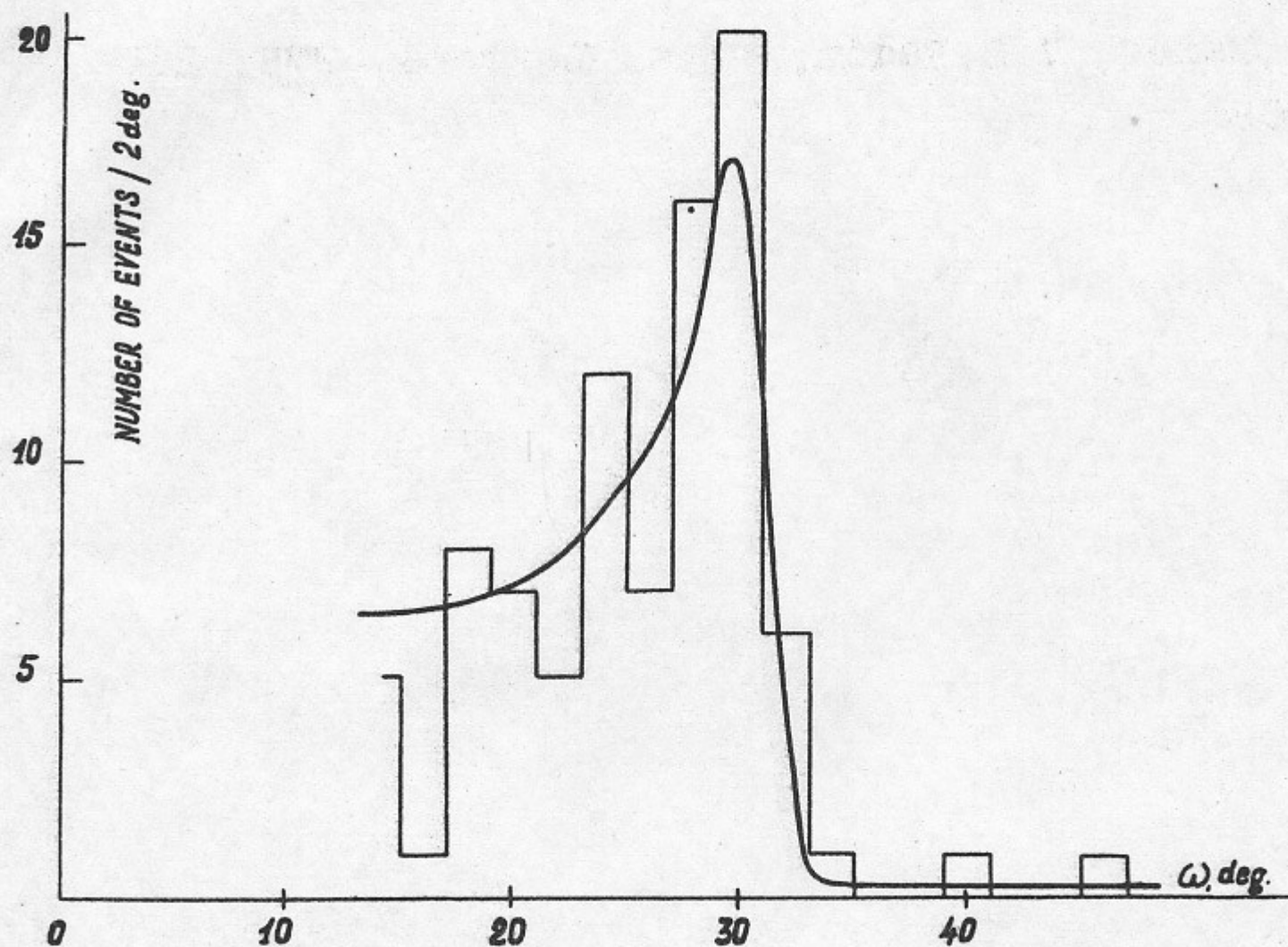3. V.N.Baier, V.S.Fadin, Phys. Letters, 27B, 223
   (1968).

Fig.1. Distribution of the $K_S^0 \to \pi^+ \pi^-$ events with respect to the non-collinearity angle. The experimental data were recalculated to the energy corresponding to the Φ -resonance maximum. The theoretical distribution for this energy is shown by the solid curve.

R e f e r e n c e s

1. V.E.Balakin et al, Phys. Letters, 34B, 328(1971).

2. Particle Data Group, April, 1971.

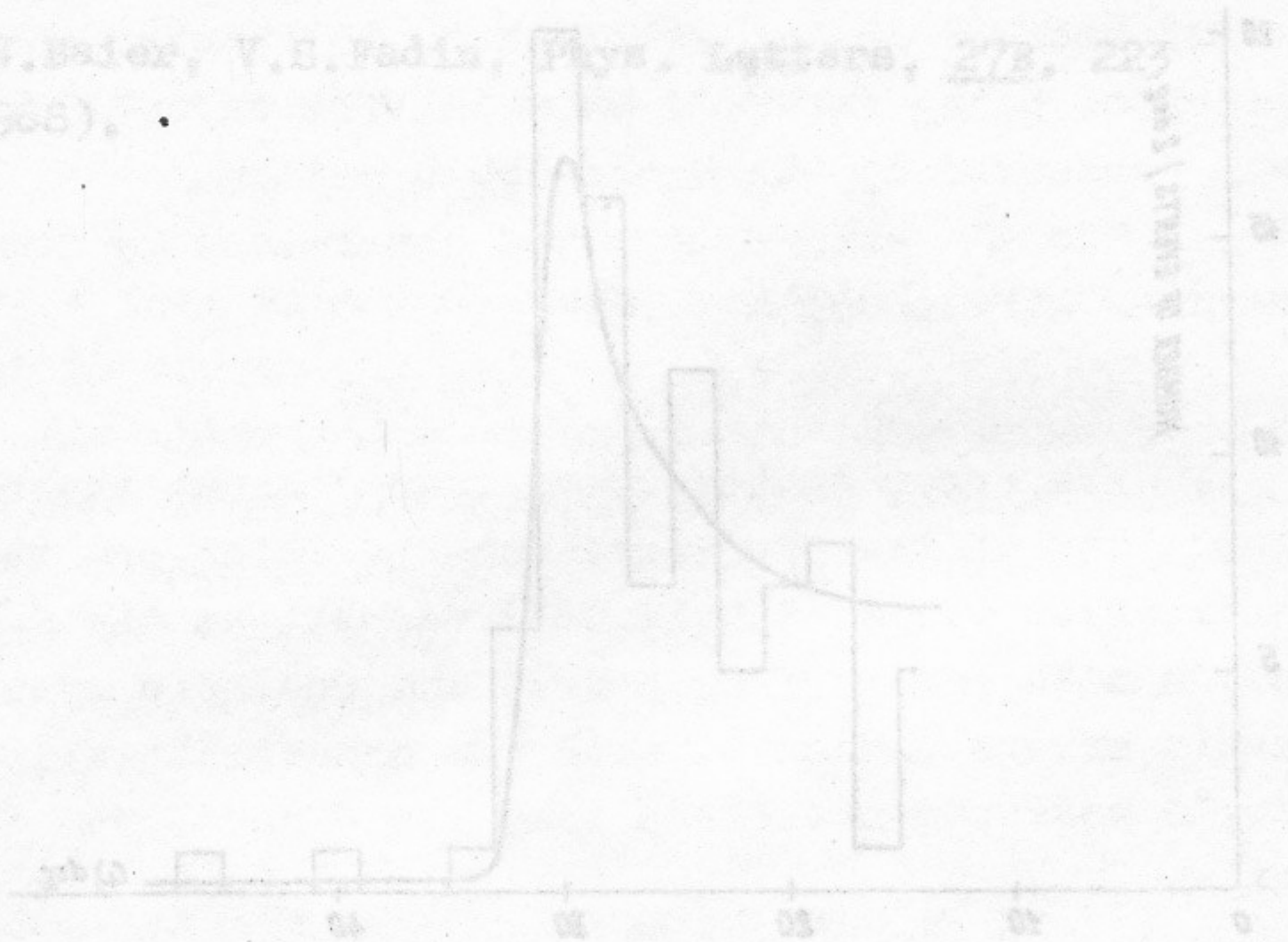3. V.N.Baier, V.S.Fadin, Phys. Letters, 27B, 223
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