B.18

Institute of Nuclear Physics

V.E.Balakin, A.D.Bukin, E.V.Pakhtusova, V.A.Sidorov,
A.G.Khabakhpashev

EVIDENCE FOR ELECTRON-POSITRON PAIR ELECTROPRODUCTION

БИБЛИОТЕКА
Института ядерной
физики СО АН СССР
ИНВ №

Novosibirsk
1971

V.E.Balakin, A.D.Bukin, E.V.Pakhtusova, V.A.Sidorov,
A.G.Khabakhpashev

INSTITUTE OF NUCLEAR PHYSICS, Novosibirsk, USSR

EVIDENCE FOR ELECTRON-POSITRON PAIR ELECTROPRODUCTION

A b s t r a c t

The process of pair electroproduction has been observed in the electron-positron interaction at the energy of 2x510 Mev. The work has been done with the colliding beam machine VEPP-2 in Novosibirsk. Cross section of this process and azimuth angular distribution for large outflight angles of produced particles have been measured.

While φ -meson experiment data processing /1/ about 100 events appeared which could not be ascribed to any of the six processes considered:

$$e^+e^- \to e^+e^-$$
$$e^+e^- \to K^+K^-$$
$$e^+e^- \to K_S^0 K_L^0$$
$$e^+e^- \to \pi^+\pi^-$$
$$e^+e^- \to \pi^+\pi^-\pi^0$$
$$e^+e^- \to \mu^+\mu^-$$

As a result of preliminary analysis the hypothesis has been put forward /2/ that those events are due to electron-positron pair electroproduction:

$$e^+e^- \to e^+e^- + e^+e^-$$

Further analysis confirmed this point of view.

This experiment was performed with the electron-positron storage ring of VEPP-2. The system of spark chambers consisted of two groups covering the solid angle of 2x0,9 steradian near the vertical direction. Each group included two thin-plate chambers which were used for the interaction point coordinates and particle outflight angles determination as well as "shower" and "range" chambers with plates of lead and stainless steel. The spark chambers were triggered by four coincidence scintillation counters. Coincidence circuit threshold was 15 Mev for electrons and 35 Mev

for pions.

Measurements have been performed at 9 particle energy values in the storage ring from 508 Mev up to 514 Mev. A quarter of the accelerator operation time was spent on the background measurements, when the beams got the vertical gap of 2 mm. The accelerator luminosity was determined by the electron-positron elastic scattering process which was detected by the same experimental arrangement. The value of luminosity integral for this experiment was $(8,5 \pm 0,37) \cdot 10^{33} cm^{-2}$.

The process revealed has the following peculiar features:

1. Particle ranges are concentrated in the region from the detection threshold 6,4 g/cm^2 to the first shower chamber gap 16,0 g/cm^2.

2. Particle flight directions are concentrated near the plane including the beams (complanarity).

3. The process isn't connected with φ -meson resonance.

4. Multiple scattering angle in foil (100 mg/cm^2 of steel and 50 mg/cm^2 of aluminum) equals 5,5 degrees.

The last circumstance permits the estimation of the effective particle energy depending on its type. Only for electron-positron component such an estimate does not contradict the known detection threshold value of coincidence circuit. For pion, for example, this multiple scattering angle corresponds to the energy of 8 Mev, i.e. much less than the detection

threshold.

The total cross section of the process $e^+e^- \to e^+e^- + e^+e^-$ is very large $\sim 4 \cdot 10^{-27} cm^2$ /3/. However, the produced electron-positron pairs must flight out mostly at small angles with respect to the beam line. Differential cross section of electron-positron pair electroproduction at large angles in electron-positron collisions was obtained quite recently by Baier and Fadin /4/. Good agreement of their calculation and our experiment results confirmed the validity of our assumption of observed process nature.

Because of the different background conditions it proved convenient to divide the whole observation region into two parts with respect to discollinearity angle $\Delta\theta$ in the plane passing through the initial beams. The results of the measurements and calculations for these regions are summarized in the table:

$\lvert\Delta\theta\rvert$ interval (degrees)	0 - 40	40 - 90
Effect	150	71
Background (normalization factor 0,30)	16	21
Admixture of the other processes considered	13 ± 5	0,2
"Clean"effect	84 ± 19	1 ± 18
Calculation according to Baier and Fadin paper /5/	65 ± 13	22 ± 5

Calculation was drawn by Monte-Carlo method, finite interaction region of the beams and particle multiple scattering being taken into account. The calculation errors given are connected with the detection threshold uncertainty.

Distribution of events in the interval $|\Delta\theta|<40^{\circ}$ with respect to azimuth discollinearity angle $\Delta\varphi$ is shown in Fig.1. Solid curve which is in excellent agreement with the experimental results corresponds to the calculation according to the Baier and Fadin formula /4/, multiple scattering and geometric experimental conditions being accounted. In the same figure for the purpose of comparison dashed line shows the calculated distribution obtained for the process with independent and isotropic particle distribution. Both curves are normalized to the total number of observed events. Dashed line corresponds to the total cross section of $2\cdot10^{-30}cm^{2}$.

In conclusion the authors express their profound gratitude to V.N.Baier and V.S.Fadin for close collaboration.

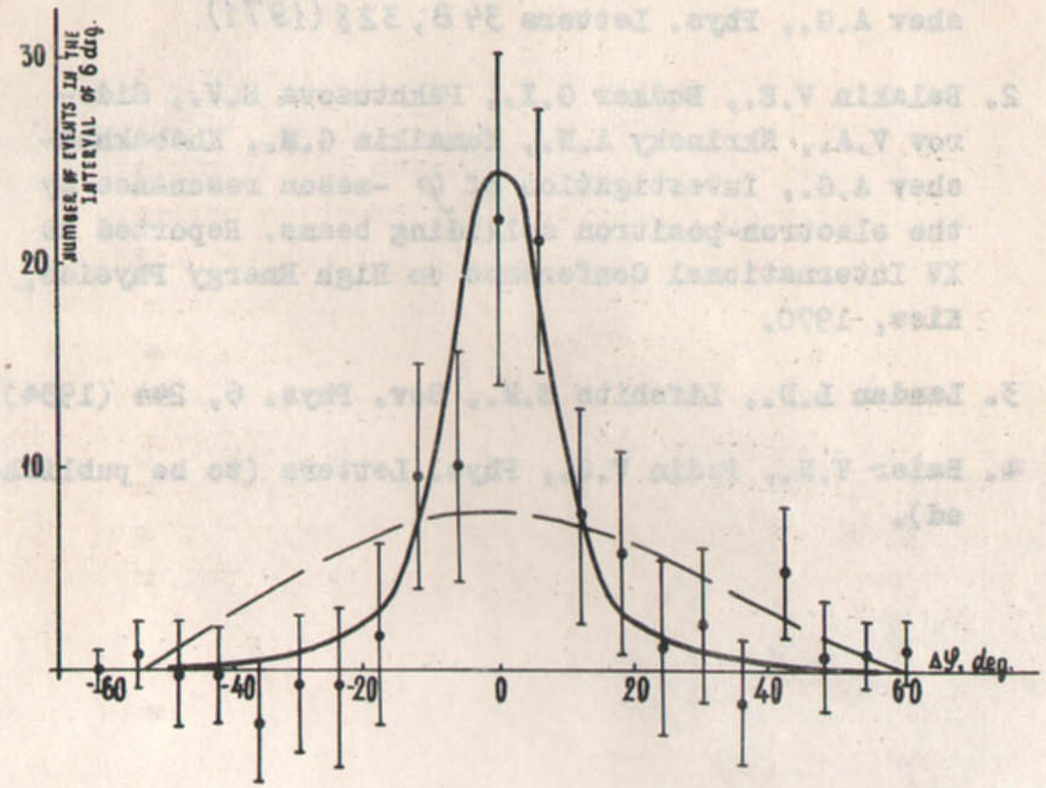

Fig.1. Pair electroproduction events distribution with respect to angle $\Delta\varphi$. Solid curve is obtained with the Baier and Fadin formulas. Dashed one represents the computed distribution for the process with independent and isotropic particle distribution.

References

1. Balakin V.E., Budker G.I., Pakhtusova E.V., Sidorov V.A., Skrinsky A.N., Tumaikin G.M., Khabakhpashev A.G., Phys. Letters *34 B*, 328 *(1971)*.

2. Balakin V.E., Budker G.I., Pakhtusova E.V., Sidorov V.A., Skrinsky A.N., Tumaikin G.M., Khabakhpashev A.G., Investigation of φ -meson resonance by the electron-positron colliding beams. Reported at XV International Conference on High Energy Physics, Kiev, 1970.

3. Landau L.D., Lifshits E.M., Sov. Phys. 6, 244 (1934).

4. Baier V.N., Fadin V.S., Phys. Letters (to be published).

Ответственный за выпуск А.Д.Букин
Подписано к печати *31.3.71.* *МН01168*
Усл. *0,4* печ.л., тираж *150* экз. Бесплатно.
Заказ № *25* . ПРЕПРИНТ

Отпечатано на ротапринте в ИЯФ СО АН СССР, нв.