ИНСТИТУТ ЯДЕРНОЙ ФИЗИКИ СО АН СССР

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UPPER LIMIT FOR THE TWO-PHOTON WIDTH OF A NEUTRAL PARTICLE WITH THE MASS OF 1.8 MeV

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UPPER LIMIT FOR THE TWO-PHOTON WIDTH OF A NEUTRAL PARTICLE WITH THE MASS OF 1.8 MeV *

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A b s t r a c t

We have searched for the production of a neutral particle, decaying into electron-positron pair, with a spin 0 and mass about 1.8 MeV using the results of our previous experiment carried out at the storage ring VEPP-4 with the detector MD-1, in which two-photon production of electron-positron pairs with small invariant mass was studied. We obtained the upper limit for the two-photon width of this particle $\Gamma_{\gamma\gamma}$ times the branching ratio B_{ee}:

$$B_{ee} \cdot \Gamma_{\gamma\gamma} < 2 \text{ eV} \qquad (90\% \text{ C.L.})$$

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The observation of peaks in energy spectra of electrons and positrons from experiments with heavy ion collisions /1/ have been interpreted as evidence for the production of a neutral particle /2,3/ with a mass about 1.8 MeV, decaying into electron-positron pair. Using the result of our previous experiment /4/, we have searched for this particle production in the two-photon reaction.

In our experiment /4/ carried out at the storage ring VEPP-4 with the detector MD-1, two-photon production of electron-positron pairs with small invariant mass was studied. The average value of an invariant mass of detected events was about 2 MeV, the momenta of produced particles were in the region 40-80 MeV. For such small particle momenta the reconstructed vertex of the event was considerably deviated from the real one due to the particle interaction in the wall of the beam pipe. Thus a deviation of $\pm$15 cm from the center of interaction region along the beam line was allowed for the reconstructed vertex of event. This allowed detection of particle with the lifetime ($\gamma \sim 100$) $\tau_0 < 5 \cdot 10^{-12}$ s.

In our experiment the invariant mass resolution was about 5-10 MeV due to the multiple scattering in the wall of the beam pipe (Fig. 1). Therefore the contribution from the hypothetic particle was searched for in the total number of detected events, rather then in the invariant mass spectrum.

The experimental visible cross section was equal to $\sigma_{exp} = 1.61 \pm 0.12$ mkb. The Monte Carlo calculation was found to be equal to 1.58 ± 0.15 mkb for the process $e^+e^- \to e^+e^- + e^+e^-$ and 0.24 + 0.06 mkb for the process of e^+e^- pair production by a synchrotron radiation photon on a counter beam electron /5/. Thus, the calculated value of the visible cross section was of $\sigma_{MC} = 1.82 + 0.16$ mkb. From these data the contribution from the hypothetic particle to the visible cross section does not exceed

$$\sigma_{res} < 0.12 \text{ mkb} \qquad (1)$$

at 90% confidence level.

The diagramm corresponding to two-photon production of a particle in the reaction $e^+e^- \to e^+e^-$ is shown in Fig. 2.

The cross section of this process is given by the expression /6/:

$$\sigma_{ee \to eeR} \propto (2J_R+1)\cdot\Gamma_{\gamma\gamma}/M_R^3$$

where J_R and M_R are a spin and mass of the particle and $\Gamma_{\gamma\gamma}$ is its two-photon width.

The calculation of the visible cross section for a e^+e^- pair from the decay of a particle with the mass of 1.8 MeV and zero spin was performed by the Monte Carlo method. To calculate the two-photon production of a pseudoscalar particle we used the program, developed by Vermaseren et al. /7/. The calculated value of the visible cross section is

$$\sigma_{vis} = (0.056 \pm 0.015)\cdot B_{ee}\cdot\Gamma_{\gamma\gamma} \quad \text{mkb/eV} \qquad (2)$$

Combining (1) and (2) we obtain the upper limit for the two-photon width $\Gamma_{\gamma\gamma}$ times the branching ratio B_{ee}:

$$B_{ee}\cdot\Gamma_{\gamma\gamma} < 2 \text{ eV} \qquad (90\%\ \text{C.L.})$$

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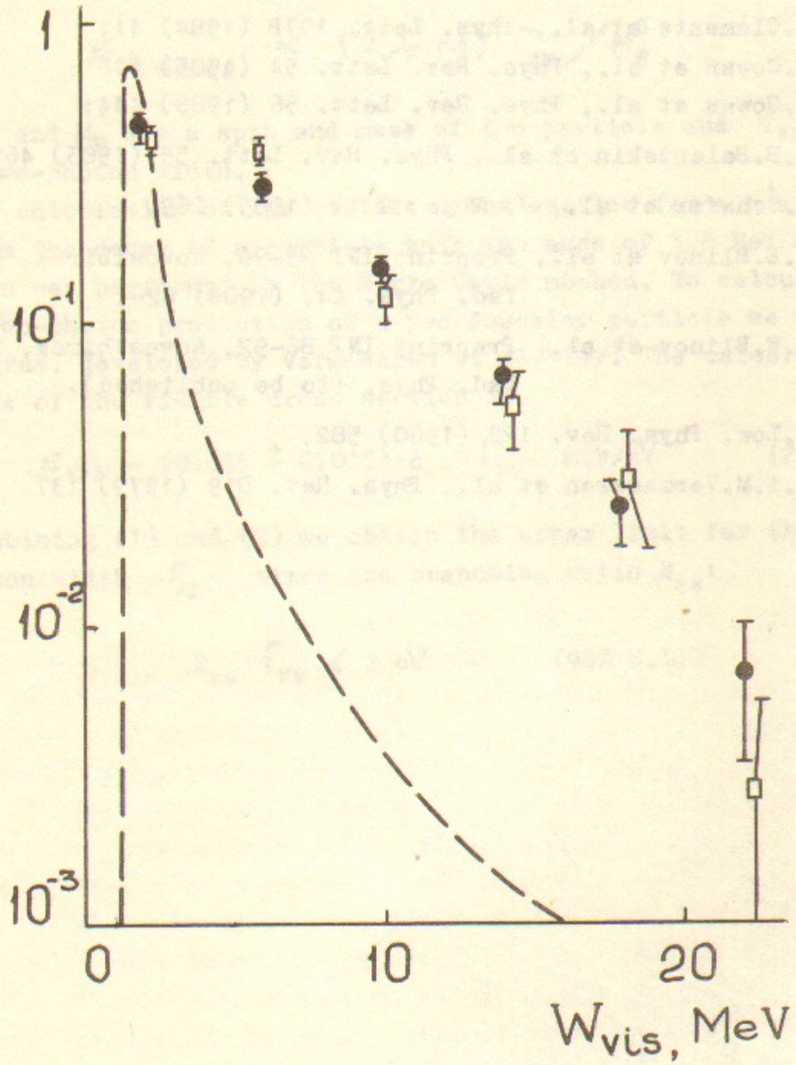

Fig. 1. The distribution over the visible invariant mass of the detected pair:
-experiment,
-simulation
The dashed line shows the distribution without interaction of the particles with the beam pipe.

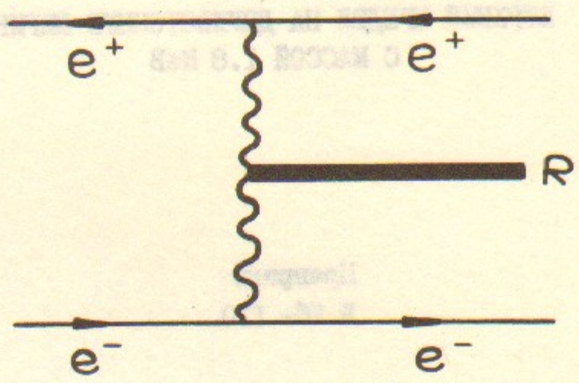

Fig. 2. Diagram for the two-photon production of a particle R.

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