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TWO-PHOTON RESULTS FROM SPEAR*

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ABSTRACT

I report results obtained by two experiments at SPEAR on the two-photon production of lepton pairs and resonances. Both experiments find agreement of lepton production with QED expectations, and observe an enhancement of the $\pi\pi$ mass spectrum in the 1250 MeV/c^2 region. The Mark II finds this enhancement not consistent with the decay of the f(1270 MeV/c^2) alone. The $\gamma\gamma$ partial width of the η' has also been measured by the Mark II.

INTRODUCTION

Two experiments, performed at SPEAR, have measured dilepton and resonance production via the two photon mechanism: $e^+e^- \to e^+e^-X$. In addition to the $\gamma\gamma \to X$ cross section, the total cross section for these processes contains the probability for the incident electrons to emit the bremsstrahlung photons. This gives the kinematic peculiarity of these events:

(1) The X system has a low mass and is confined at a very low transverse momentum with respect to the beams.

(2) The cross sections rise logarithmically with the beam energy.

SP 14: U.C. SAN DIEGO[1]

A luminosity of 10 pb^{-1} was accumulated for a center-of-mass energy between 6 and 7.2 GeV/c^2. The apparatus consists of 3 parts:

(1) A small angle detector (polar angle θ from 55 to 180 mrad) tags the outgoing e^+e^-. Doubly tagged events are selected for which one can compute the squared mass of the $\gamma\gamma$ system (M_X^2).

(2) An inner detector ($15^o \leq \theta \leq 30^o$) is able to separate e, μ and hadrons. 28 events with a μ and 30 events with a π were recorded, showing that in this solid angle, π and μ rate are comparable. Figures 1a and 1b display the M_X^2 spectrum for these events. On Fig. 1a the line gives the normalized QED expected spectrum which agrees very well with the data.

(3) A crude central detector provides, in a wide solid angle ($22^o \leq \theta \leq 158^o$) information on the azimuth of charged particles. It is used to search for two body decay of resonances. Figures 1c to 1f give the M_X^2 distributions for two prong events. Figure 1c shows all the 189 events while Fig. 1e is restricted to tagged events which have both electrons on the same side of an horizontal plane. This configuration cannot be faked by the Bhabha annihilation events that contaminate Fig. 1c in the zero mass region. The ee and $\mu\mu$

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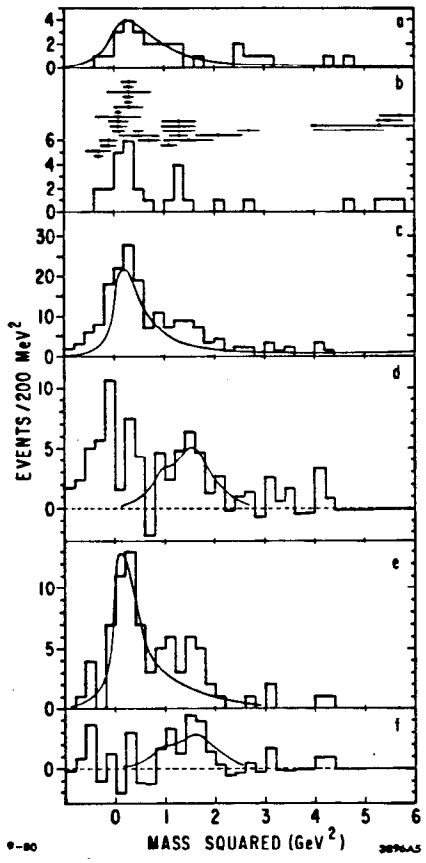

Fig. 1. SP 14—histograms of the $\gamma\gamma$ mass squared (see text).

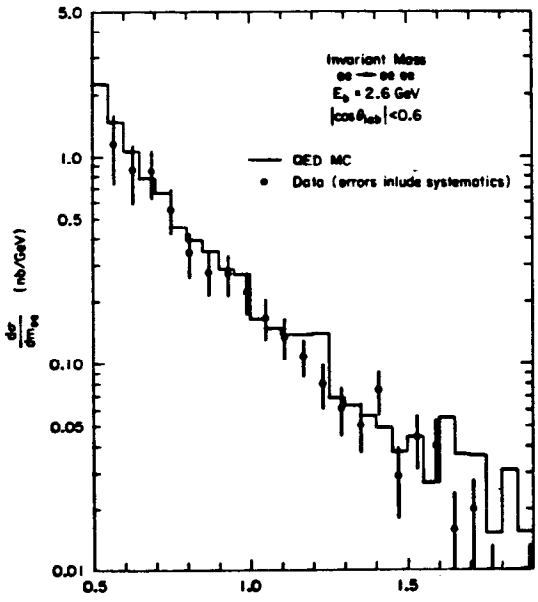

Fig. 2. MARK II—M_{ee} (GeV).

event rate can be computed from QED (solid lines) and subtracted from Figs 1c and 1e to get Figs. 1d and 1f respectively. Both distributions display, above the QED continuum, an enhancement around 1.5 $(GeV/c^2)^2$ of 26 events. The process $\gamma\gamma \to \eta' \to \rho\gamma$ is expected to contribute 5 events to this region (computed from the known $\gamma\gamma$ width of the η').[2] This leaves 21 events that can be f(1270), ε(1100 to 1300) or A_2(1310) decay. The result is that if the resonance responsible for these events has a spin 2, its total $\gamma\gamma$ decay width is $9.5 \pm 3.9 \pm 2.4$ keV.

SP 29 (MARK II): SLAC-LBL

A luminosity of 14 pb^{-1} was obtained between 4.4 and 7.2 GeV/c^2. The MARK II detector has no tagging system. Two-photon events are selected by requiring the observation of exclusive channels of low invariant mass ($\leq$ 2 GeV/c^2) produced at low transverse momentum ($\leq$ 250 MeV/c).

(1) η' production: I will just recall briefly this published result.[2] From 61 $\eta' \to \gamma\gamma$ events observed, the $\gamma\gamma$ partial width of the η' was determined to be

$$\Gamma_{\eta \to \gamma\gamma} = (5.8 \pm 1.1 \pm 1.2) \text{ keV}$$

which together with the known branching ratio gives a total width for the η' in very good agreement with a recent missing mass measurement.[3]

(2) 2 prong production: In addition to the M_X and p_T cut, the 2 tracks are required to be well inside the liquid argon detector solid angle ($|\cos\theta| \leq 0.6$).

— 2 prong ee: For the events in which the two particles are identified by the liquid argon as electrons, the mass plot of Fig. 2 is obtained. The data (dots) are in very good agreement with a complete QED computation

using the Vermaseren program.[4] Not shown here is the very good agreement with the two photon process of the total p_T and center-of-mass energy of these events.

— 2 prong all: Using for each particle the π mass, the mass distribution of all the 2 prong events was obtained (not shown here). Below 900 and above 1400 MeV/c^2 its shape is perfectly similar to the computed QED distribution (ee and $\mu\mu$ pairs) but 8% higher. The QED continuum is normalized to the data in the 700-900 MeV/c^2 region. The subtracted distribution is shown in Fig. 3. Possible sources for the excess of 540 events between 950 and 1500 MeV/c^2 are the decay into $\pi\pi$ of the C even resonances: S*(980), f(1270) and ε(between 1100 and 1300). If all these events are f (mass = 1270 MeV/c^2, width = 180) the mass distribution is expected to be the line drawn on Fig. 3. If this assumption were true, the $\gamma\gamma$ partial width of the f(spin and helicity 2) would be 3.5 ± 0.6 keV. But the fit is bad; the mass spectrum is not consistent with the decay of the f alone. An upper limit of the f to $\gamma\gamma$ partial width is

$$\Gamma_{f \to \gamma\gamma} \leq 4.7 \text{ keV (95\% confidence level)} \quad .$$

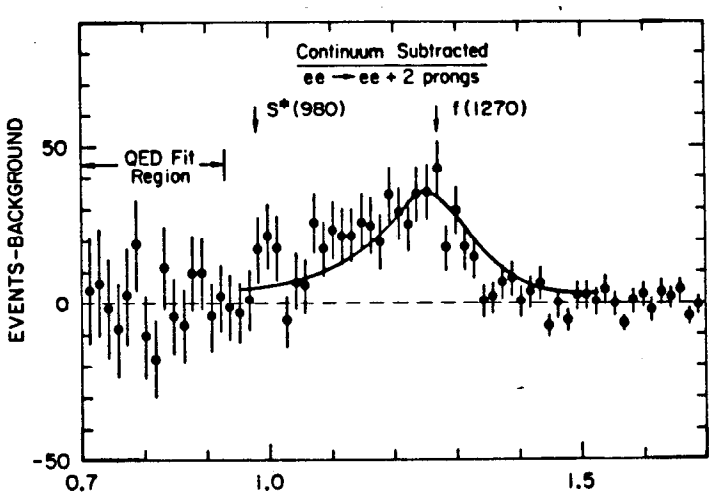

Fig. 3. MARK II — $M_{\pi\pi}$ (GeV).

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4. J. Smith, J.A.M. Vermaseren and G. Grammer, Phys. Rev. D15, 3220 (1977).