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SOME FIRST RESULTS FROM THE MARK II AT SPEAR

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ABSTRACT

Preliminary results are given from the Mark II experiment at SPEAR on radiative decays of the $\psi'(3684)$ and on inclusive baryon production from 3.67 to 7.4 GeV center-of-mass energy. A 90% confidence level upper limit of 0.12% is given for $BR[\psi' \to \gamma\eta_c'(3455)] \times BR[\eta_c'(3455 \to \gamma\psi)]$.

1. INTRODUCTION

This paper presents some first results from the Mark II experiment at the Stanford Linear Accelerator Center e^+e^- storage ring facility SPEAR. These include results on:

i) radiative decays of the $\psi'(3684)$;

ii) inclusive baryon production in e^+e^- annihilation.

A number of other topics are discussed by G. Gidal elsewhere in these proceedings[1].

2. THE MARK II DETECTOR

A schematic diagram of the Mark II detector is shown in Fig. 1. Particles originating in the intersection region pass through a thin stainless steel vacuum pipe, a cylindrical scintillation pipe counter, 16 layers of cylindrical drift chambers[2], and a layer of 48 time-of-flight (TOF) scintillation counters.

They then may penetrate the 1.3 radiation length solenoidal coil and enter one of 8 lead-liquid argon (LA) shower counters[3] (14 r.ℓ.) which surround the inner detector. In addition, a muon detection system uses proportional tubes interspersed among the split magnet flux returns shown in Fig. 1 and additional iron absorbers on the top and sides which are not shown in the figure. Finally, both endcap regions of the detector are covered by additional shower detectors.

Performance features may be summarized here by:

i) 200μ average spatial resolution for the drift chambers which provide highly efficient tracking for p > 100 MeV/c over 75% of 4π ster. and some coverage out to 85% of 4π ster.

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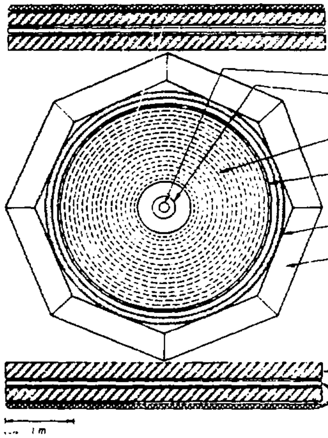

Fig. 1. Schematic view of the Mark II detector.

ii) 300 psec. time-of-flight resolution for hadrons (270 psec. for Bhabha events) over 75% of 4π ster. giving 1σ π/K separation at 1.3 GeV/c and 1σ K/p separation at 2.0 GeV/c.

iii) $\delta E/E = .12/\sqrt{E}$ (E in GeV) energy resolution for photons and electrons from the liquid argon shower counters which cover 73% of 4π ster. The efficiency of these devices has been measured using the photons in fully-constrained $\psi \to \pi^+\pi^-\pi^0$ and $\pi^+\pi^-\pi^+\pi^-\pi^0$ events and agrees well with detailed Monte Carlo calculations. This efficiency rises from about 30% at $E_\gamma = .15$ GeV to approximately 85% at $E_\gamma = .30$ GeV and 95% above .55 GeV.

3. RADIATIVE DECAYS OF THE $\psi'(3684)$

Events of the form

$$\psi' \longrightarrow \gamma\gamma\psi \qquad \psi \to e^+e^-,\ \mu^+\mu^- \tag{1}$$

are selected by the following criteria:

i) exactly 2 tracks of opposite charge from the primary vertex with an invariant mass between 2.8 and 3.4 GeV (p_e < 1.75 GeV/c).

ii) At least 2 photons found in the liquid argon, each separated from the nearest charged track by at least 0.2 m. (E_γ > .1 GeV). More than 2 photons are allowed due to the possibility of spurious "photons" generated from random preamplifier noise.

These events are then fit to the hypothesis (1) using the program SQUAW with 5 constraints. Figure 2(a) shows the $\gamma\gamma$ mass spectrum for events satisfying (1) with a $\chi^2 < 15$. The events in the prominent η peak at .548 GeV coming from $\psi' \rightarrow \eta\psi$ are then eliminated by requiring $m_{\gamma\gamma} < .530$ GeV, leaving events which are candidates for the desired cascade decay

$$\psi' \longrightarrow \gamma\chi, \quad \chi \longrightarrow \gamma\psi, \quad \psi \longrightarrow \ell^+\ell^- \qquad (2)$$

The high mass $\gamma\psi$ combinations are plotted in Fig. 2(b) and show two clear peaks corresponding to the $\chi(3505)$ and $\chi(3550)$. In addition, there is a smooth background consistant in both size and shape with that expected from $\psi' \rightarrow \pi^0\pi^0\psi$. While there is no clear peak corresponding to the $\chi(3410)$, the events near that mass are consistant with the small branching ratio previously observed for that state[4,5,6,7]. On the other hand, there is no evidence in these data for a peak at 3455 MeV which has been previously reported[4] as $\chi(3455)$ and which has been suggested as a candidate for the pseudoscalar η_c'. Table 1 presents preliminary branching ratios obtained using our knowledge of the detector acceptance.

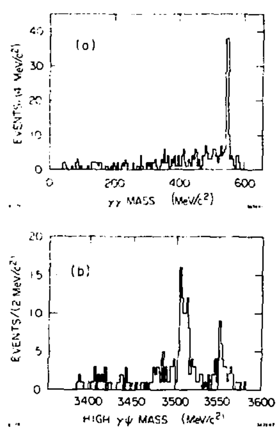

Fig. 2(a). $\gamma\gamma$ mass spectrum for events satisfying $\psi' \rightarrow \gamma\gamma\psi$, $\psi \rightarrow \ell^+\ell^-$

2(b). High mass $\gamma\psi$ combinations.

Table 1

Summary of Branching Ratios* $\psi' \to \gamma\gamma\psi$

	Mark II %	Mark I[4] %	DESY-Heidelberg[7] %
η	3.8 ± .5	4.3 ± .8	3.6 ± .5
$\chi(3550)$	1.2 ± .3	1.0 ± .6	1.0 ± .2
$\chi(3505)$	2.5 ± .3	2.4 ± .8	2.5 ± .4
$\chi(3455)$	<.12**	.8 ± .4	<.25
$\chi(3410)$	.08 ± .08	.2 ± .2	.14 ± .09

* $BR[\psi' \to \gamma\chi] \times BR[\chi \to \gamma\psi]$

** 90% confidence level

4. INCLUSIVE BARYON PRODUCTION IN e^+e^- ANNIHILATIONS

The inclusive production of $\bar{p}$, Λ and $\bar{\Lambda}$ has been studied with data concentrated in the center-of-mass energy range 4.5-6.0 GeV covering the region of a previously reported rise in $R(p+\bar{p})$[8]. Multi-hadron events with at least 3 detected tracks are selected. The time-of-flight system is used to identify p and $\bar{p}$ to 2.0 GeV/c using a weight method which is helpful above 1.3 GeV/c. However, only the $\bar{p}$ results are used here due to beam-gas backgrounds. The Λ and $\bar{\Lambda}$ are observed by their $p\pi^-$ and $\bar{p}\pi^+$ decay modes with an rms mass resolution of about 4 MeV.

Preliminary results, corrected for acceptance, are presented in Fig. 3 as a ratio of the inclusive cross-section to the μ-pair production cross-section. For the proton case, $R(\bar{p}+p) = 2\sigma_{\bar{p}}/\sigma_{\mu\mu}$. All errors shown are statistical only and do not include an estimated systematic uncertainty of ±30%, believed largely energy independent[9].

The measurements are consistant with previous experiments[8,10]. They show in detail, however, that the rise in the inclusive baryon production in e^+e^- annihilation is smooth and occurs principally between 4.6 and 5.2 GeV center-of-mass energy.

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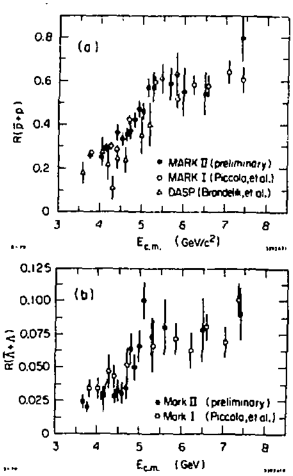

Fig. 3(a). Inclusive $\bar{p}$ production vs. c.m. energy.

3(b). Inclusive Λ and $\bar{\Lambda}$ production vs. c.m. energy.

* * *

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