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THE DISVOERY OF A SECOND NARROW RESONANCE IN e^+e^- ANNIHILATION

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THE DISCOVERY OF A SECOND NARROW RESONANCE IN e^+e^- ANNIHILATION*

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ABSTRACT

We have observed a second sharp peak in the cross section for $e^+e^- \rightarrow$ hadrons at a center-of-mass energy of 3.695 ± 0.004 GeV. The upper limit of the full width at half maximum is 2.7 MeV.

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The recent discovery of a very narrow resonant state coupled to leptons and hadrons[1,2,3] has raised the obvious question of the existence of other narrow resonances also coupled to leptons and hadrons. We therefore began a systematic search of the mass region accessible with the SLAC e^+e^- storage ring SPEAR and quickly found a second narrow resonance decaying to hadrons. The parameters of the new state (which we suggest calling $\psi(3695)$) are

$$M = 3.695 \pm 0.004 \text{ GeV}$$
$$\Gamma < 2.7 \text{ MeV (FWHM)}$$

where the mass uncertainty reflects the uncertainty in the absolute energy calibration of the storage ring.

The $\psi(3695)$, like the $\psi(3105)$, was found using the SLAC-LBL magnetic detector at SPEAR.[4] The luminosity monitoring, event acceptance criteria, and storage ring energy determination have been described previously.[1]

The new feature of this run is the search procedure used to hunt for narrow e^+e^- resonances. In the search mode the storage ring energy is increased in about 1 MeV steps ($E_{CM} = 2 \times E_{BEAM}$) every three minutes. The data taken during each step are analyzed in real time and the relative cross sections computed at the end of each step. Figure 1a shows the search mode data taken during a calibration scan over the previously discovered $\psi(3105)$. Figure 1b shows the data taken during the first scan which began at a ring energy of 1.8 GeV. A clear indication of a narrow resonance with a mass of about 3.70 GeV is seen. It should be emphasized that we have not yet scanned any mass region other than that between 3.6 and 3.71 GeV.

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