Discovery of a Narrow Resonance in e^+e^- Annihilation

2018-07-06

Subtract

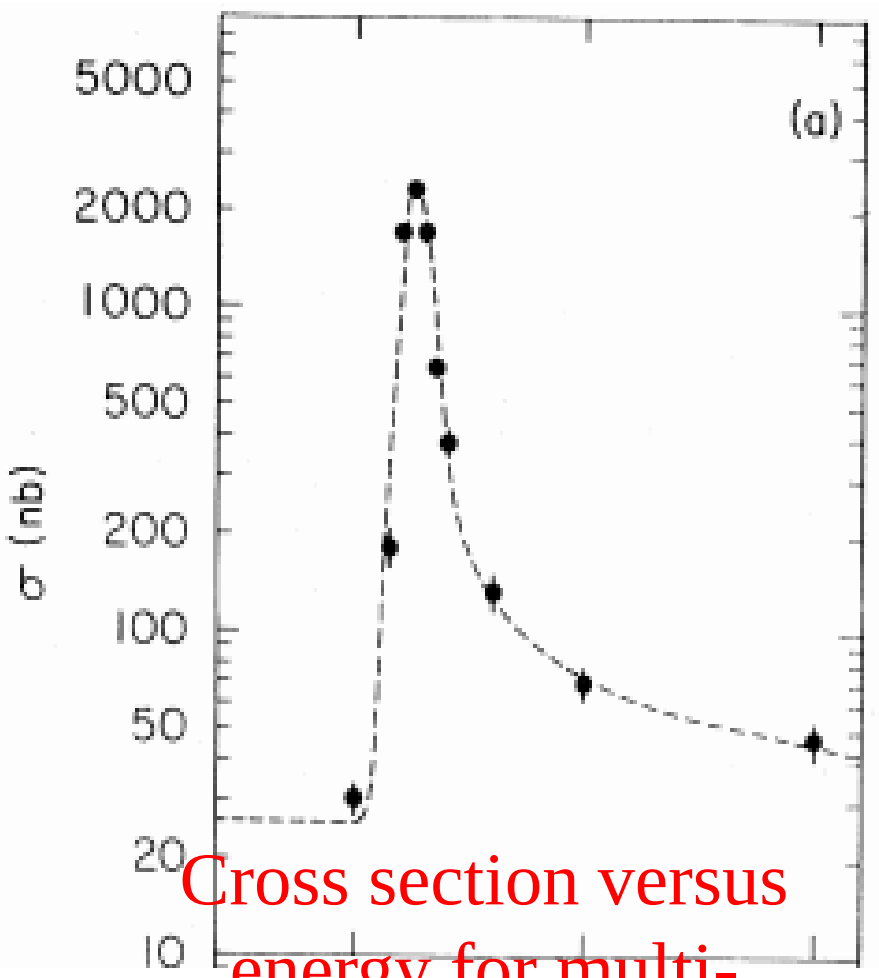
- We have observed a very sharp peak in the cross section for $e^+e^- \rightarrow$ hadrons, e^+e^-, and possibly μ^+, μ^- at a center-of-mass energy of 3.105 +/- 0.003 GeV

- The upper limit to the full width at half-maximum is 1.3 MeV

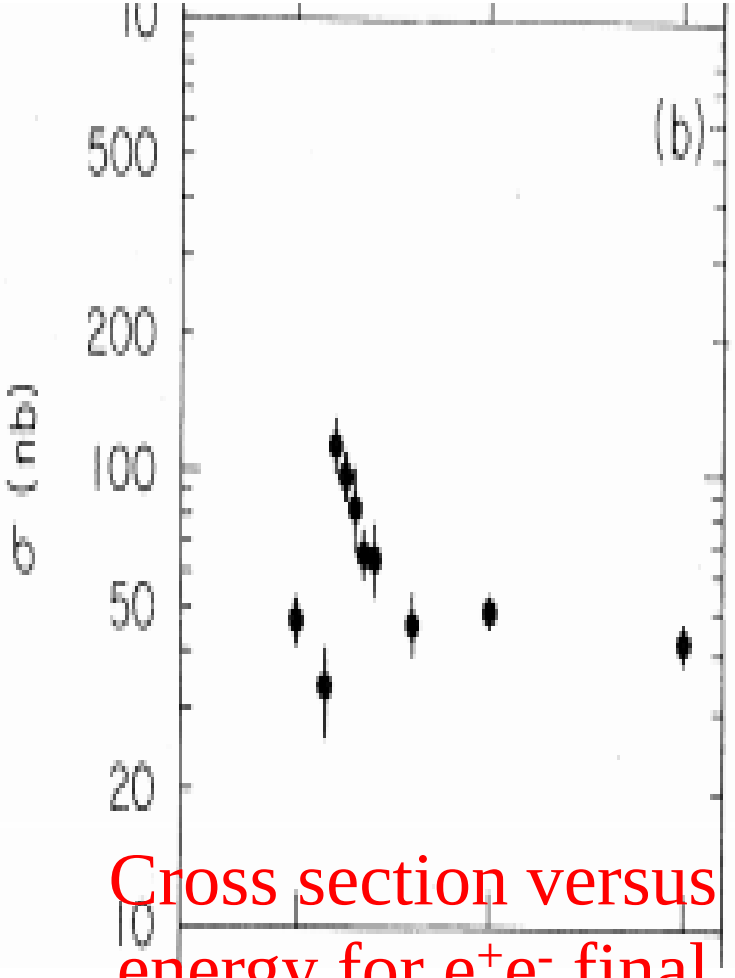
Experiment Method

- Use electron and positron beam
- Use much finer energy steps(previous: 20MeV)
- Use a nuclear magnetic resonance magnetometer to monitor the ring energy

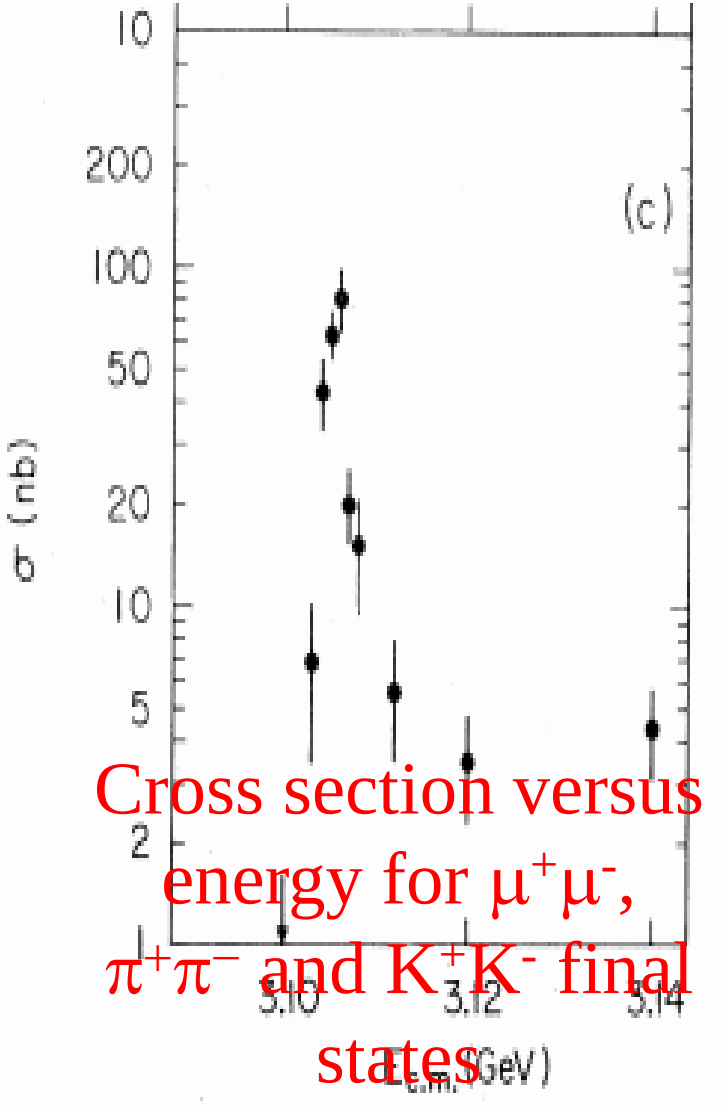
Experiment Results



Cross section versus energy for multi-hadron final states



Cross section versus energy for e^+e^- final states



Cross section versus energy for $\mu^+\mu^-$, $\pi^+\pi^-$ and K^+K^- final states

Discussion

- Hadronic events are required to have in the final state either ≤3 detected charged particles or 2 charged particles noncoplanar by > 20°

The observed cross section rises sharply from a level of about 25 nb to a value of 2300 +/- 200 nb at the peak and then exhibits the long high-energy tail characteristic of radiative corrections in e^+e^- reactions.

- ✓ The expected Gaussian c.m. energy distribution (s=0.56 MeV), folded with the radiative processes, is shown as the dashed curve in Fig. (a)
- ✓ The width of the resonance must be smaller than this spread; thus an upper limit to the full width at half-maximum is 1.3 MeV

Discussion

- Outside the peak in Fig.(b) this cross section is equal to the Bhabha cross section integrated over the acceptance of the apparatus
  - ✓ The $e^+e^- \rightarrow$ hadron cross section is presumed to go through the one-photon intermediate state with angular momentum, parity, and charge conjugation quantum numbers $J^{PC} = 1^{--}$
  - ✓ It is difficult to understand how, without involving new quantum numbers or selection rules, a resonance in this state which decays to hadrons could be so narrow