$e^+e^- \longrightarrow B\bar{B}$ in soliton models

- Frascati data:

  $\sigma(e^+e^- \to p\bar{p})/\sigma(e^+e^- \to n\bar{n}) \approx 1$ at treshold

  quite puzzling, as in Feynman diagram description

$$e^+e^- \overset{QED}{\longrightarrow} \gamma^* \overset{QED}{\longrightarrow} q\bar{q} \overset{QCD}{\longrightarrow} B\bar{B}$$

QCD is flavor-blind, so expect

x-section $\propto$ to sum of (quark charges)^2:

$$\sigma(e^+e^- \longrightarrow B\bar{B}) \propto \sum_e q_e^2$$

- Similar puzzle from CLEO (and L3) data on

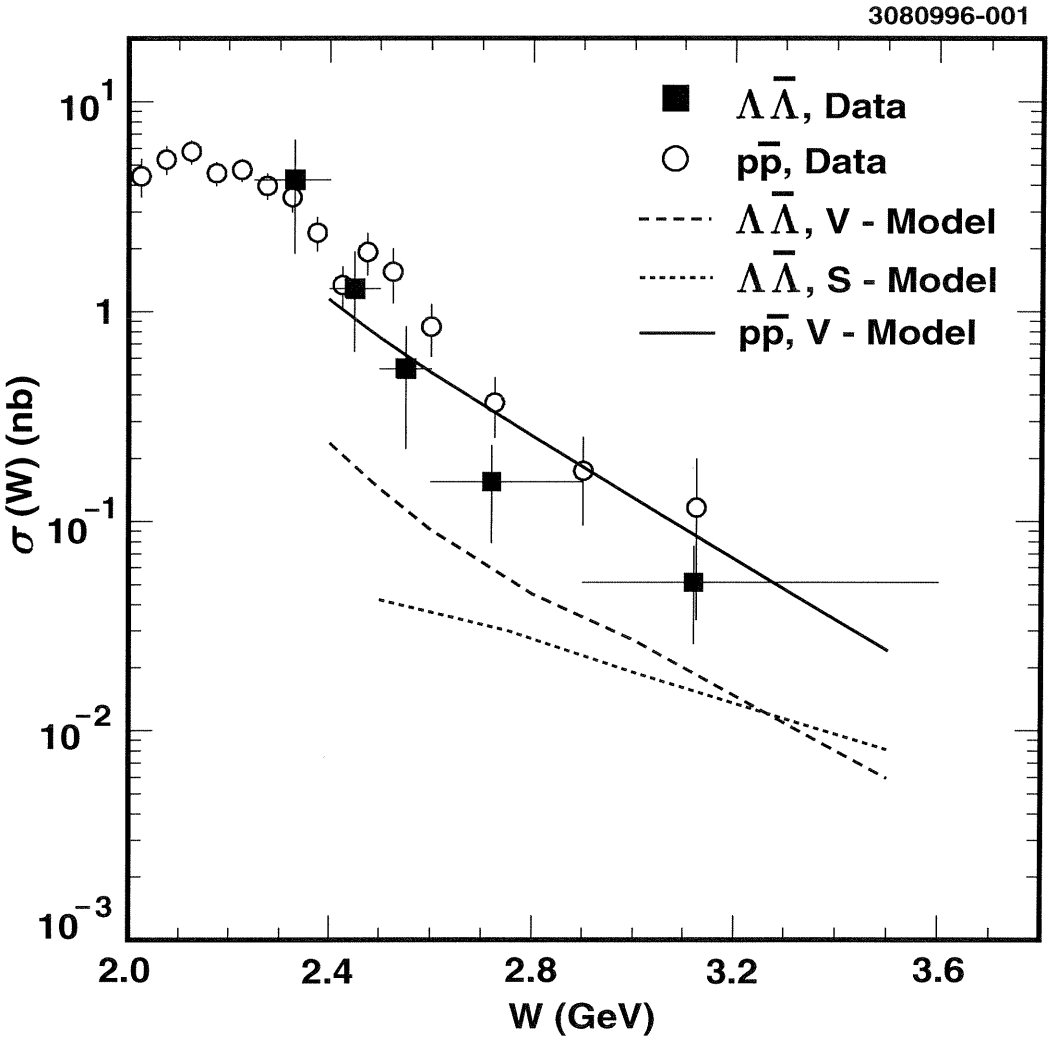
$$\gamma\gamma \longrightarrow B\bar{B} \qquad\qquad B = \Lambda, p$$

close to threshold

$\gamma\gamma \to p\bar{p}$ vs. $\gamma\gamma \to \Lambda\bar{\Lambda}$

similar to $n\bar{n}$ vs. $p\bar{p}$ in e^+e^- :

equal cross-sections at threshold



CLEO data for $\sigma_{\gamma\gamma\to\Lambda\bar{\Lambda}}(W)$, $\sigma_{\gamma\gamma\to p\bar{p}}(W)$ for $|\cos\theta^*| < 0.6$.

Vertical error-bars include systematic uncertainties.
Horizontal markings indicate bin width.
S-model: scalar quark-diquark model;
V-model: vector quark-diquark model;

after S. Anderson *et al.*, Phys. Rev. **D56**(1997)R2485, hep-ex/9701013.

$\Longrightarrow$ naive Feynman diagram description clearly wrong at threshold

alternative description in soliton picture:

baryons $\Longleftrightarrow$ chiral solitons (Skyrmions)

helpful to thing about the reverse processes:

$$B\bar{B} \longrightarrow e^+e^-$$

and

$$B\bar{B} \longrightarrow \gamma\gamma$$

a two-stage process:

(1) $B\bar{B} \longrightarrow$ pions: strong interaction, flavor-blind

soliton-antisoliton annihilation – *very fast*

memory of initial state lost - $p\bar{p}$ vs. $n\bar{n}$, etc.

(2) pions $\longrightarrow e^+e^-$

pions $\longrightarrow \gamma\gamma$

etc.

a more detailed description of $B\bar{B} \to$ pions $\to e^+e^-$

$N\bar{N}$ annihilation $\Leftrightarrow$ Skyrmion-anti-Skyrmion $(S\bar{S})$ annihilation.

immediately when S and $\bar{S}$ touch, a classical pion wave emerges as a coherent burst, taking away energy and baryon number as fast as causality permits.

after the fast annihilation, a spherically symmetric "blob" of pionic matter is formed, with size $\sim$1 fm, $N_{baryon} = 0$, and $E_{tot} = 2M_N$

further evolution of the system & branching rates for various channels are completely determined by the "blob" parameters; in particular, no memory whether initial state was $p\bar{p}$ or $n\bar{n}$

a crude model: sum over intermediate states with n pions, where n goes over all allowed values,

$$\sigma(p\bar{p} \to e^+e^-) \sim \sum_n \sigma(p\bar{p} \to n\pi) \times \sigma(n\pi \to e^+e^-)$$

and similarly for $n\bar{n} \to e^+e^-$.

$\Longrightarrow \sigma(e^+e^- \to p\bar{p}) = \sigma(e^+e^- \to n\bar{n})$

a better model: use amplitudes, Σ over all intermediate states

$\Longrightarrow$ Novosibirsk precision low-E data for $e^+e^- \to$ hadrons

e^+e^- Annihilation into Hadrons