New Hadronic States Above 1.7 GeV

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March 1999, SLAC
Workshop on the \( \tau \)-charm Factory

* based on work by P. Freund and J. Rosner (PRL68 (1992) 765.)
Introduction

A reminder that there are good reasons to think that there might be a lot of mesons above 1.7 GeV.

Is hadronic physics described by a string theory of some sort?

- String-like picture of confinement $V = kr$; Casimir effect gives universal Coulomb-like piece $V = kr - \frac{\text{const.}}{r}$
- Regge trajectory $J = \alpha M^2$ naturally occurs in a string theory
- Successes of string fragmentation (i.e. LUND model) – the “string effect”
- String tension depends on temperature: Tension $\rightarrow 0$ : deconfinement

- Problems with quantization
- Not clear what sort of a string theory would make sense
Mesons, Baryons, and Tachyons

- Number of hadrons grows exponentially with mass (expected as number of partitions of a string grows)
- Avoiding tachyons ($m^2 < 0$, unstable): difference between number of mesons and number of baryons rises only as a low power of energy (Kutasov and Seiberg)
  - Supersymmetry would (obviously) do the trick
  - But supersymmetry isn't needed – something weaker will do!
From Freund and Roeser

(non-strange meson), 2 otherwise

\[ m_s = I \] if self-charge-conjugate

\[ m_s = I \] if angular momentum, parity, and isospin

\[ M = (2J + 1)(2J + 1) m_s \]

Count states weighted by: proportion of states above (Formula 6)
Qualitative Discussion

- Exponential growth as expected
- Mesons win at the beginning:
  - Without $\chi_{SB}$, pions and kaons are massless
  - Lowest mass vectors expected lighter than lowest mass baryons (constituent quark model)
- Between 1.2 and 1.7 GeV nice matching; lots of detailed phase-shift analyses in this mass range
- Above 1.7 GeV baryons winning; less detailed phase-shift analyses

- Expect a lot more mesons above 1.7 GeV! (?)
- Exotics (i.e. 4 quark or more-quark states, glueballs)?
Conclusions

If one buys the idea (and I think most experimentalists, at least, are so inclined) that stringy theories describe hadrons, then:

- Lots of physics to be expected just above 1.7 GeV!
- Good hunting ground in radiative charmonium decays — tag invariant mass with photon and do detailed analyses of hadronic recoil products!