New Hadronic States Above 1.7 GeV

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* 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!**

Counting States

- **Count states weighted by**

$$W = (2I+1)(2J+1)W_c$$

- I = **isospin**
- J = **angular momentum**
- $W_c = 1$ **if self-charge-conjugate (non-strange meson), 2 otherwise**

From Freund and Rosner

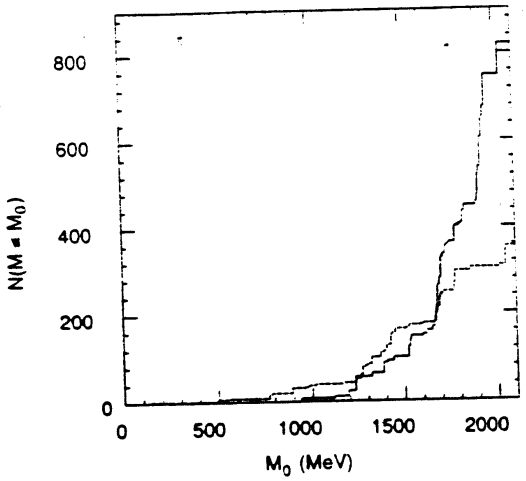

FIG. 1. Number of states with mass $M \leq M_0$ for mesons (dashed histogram) and baryons (solid histogram).

Qualitative Discussion

- **Exponential growth as expected**
- **Mesons win at the beginning:**
  - **Without χSB, 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!**