Physics 131 **Spring 2009**

Particle Physics Seminar #5

Textbook: Griffiths - Introduction to Elementary Particles
Website: (all notes referred to below are on web site)

http://chaos.swarthmore.edu/courses/Phys093_2009/index.html

Readings:

REQUIRED: Griffiths - Chapter - 5
02 Ch20_RWE_EM

Topic(s): Bound States

Professor Lecture Topic(s): Relativistic Wave Equations

Problems:

Griffiths 5-07 - How many energy levels?
5-08 - Positronium energy levels
5-14 - Construct octet states
5-17 - Construct spin-flavor states
5-20 - Calculate magnetic moments

Extra Problem 8 - Prove that in the quark model, no meson has $J^{PC} = 1^{-+}$. (Hint: try to find a consistent set of and values that can add to give j = 1 and give P =-1 and C = +1.

Extra Problem 9 - A nucleon has diameter of $\sim 10^{-15} m$. Consider a model of the nucleon as three quarks trapped in a potential well with a diameter of $\sim 10^{-15} m$.

(a) Use the uncertainty principle to do an order of magnitude estimate of the kinetic energy of each quark. Ignoring binding energy between the quarks, what would you estimate for the mass of a nucleon? How does your result compare with the true value?

(b) Not unexpectedly, elementary particles such as quarks and leptons seem to be even smaller. the size of an electron has been limited to be $<\sim 10^{-18} m$, for example. Quark size limits are more difficult, but $< 10^{-16} m$ is not a bad guess. Suppose that quarks or leptons are composite particles. Use the uncertainty

principle to estimate the kinetic energy of any sub-particle inside an up quark or inside an electron. Compare your result to the masses of these particles.

(c) Do you think your result is compatible with the idea that quarks and leptons have substructure? Why or why not?

Extra Problem 10 - Find the Λ_c^+ baryon (mass = 2285 MeV) in the Particle Data Booklet. Using the spin and flavor content of this baryon and Table 4.4 in Griffiths, calculate the expected mass of the Λ_c^+ using the methods of section 5.6 of Griffiths. How well does your value agree with the actual mass?