Physics 711, Fall 2005 Delayed Midterm Exam O.W. Greenberg

Please sign that you did this exam alone.

1. There are several measurable cross sections for πN scattering, $\pi^+ p \to \pi^+ p$, $\pi^0 p \to \pi^0 p$, $\pi^0 p \to \pi^+ n$, $\pi^- p \to \pi^- p$, $\pi^- p \to \pi^0 n$. (Some are harder to measure than others.) Assuming all the πN collisions are dominated by $\pi N \to N^\star \to \pi N$, where $N^\star$ is a resonance with either $I = 1/2$ or $I = 3/2$ in the direct (s) channel, find all these cross sections in terms of two parameters, one for each value of I. Note that the cross section is the absolute value squared of the matrix element (or amplitude) for the scattering if you ignore phase space, which is almost the same for all these processes.

2. Assume there is a particle that Georgi calls a "quix," see p 219 in Georgi. Let the quix, Q, be a $(6, 1, 1)$ under $(SU(3)_c, SU(3)_f, SU(2)_s)$.

(a) Find the simplest bound states (which always must be color singlets) with one quix and some number of light quarks (u, d, s) and find the flavor and spin quantum numbers of these bound states.

(b) Same with one quix and some number of light antiquarks.

(c) Same with at least one light quark and one light antiquark.

(d) Which of your bound states above can decay to baryons, and why?

3. Consider the n-dimensional Poincare' group P_n (not including reflections), $x' = [a, \Lambda]x = \Lambda x + a$, where Λ is in $SO(1, n-1)$ and a is in R^n.

a. Write the group multiplication law, i.e. $[a_2, \Lambda_2][a_1, \Lambda_1]$.

b. Write the identity.

c. Calculate the inverse of $[a, \Lambda]$.

d. The sets $\{[0, \Lambda]\}$ and $\{[a, 1]\}$ are each subgroups. Show by calculations whether either subgroup is an invariant subgroup .

e. If there is an invariant subgroup, to what group is the factor group of P_n by the invariant subgroup isomorphic?

4. Find the $(SU(6), L^P)$, (J^P, S) and (Y, I) content of the lowest three-quark baryon states with all quarks in S-states or one quark in a P-state. Here L^P is orbital angular momentum and parity, J^P is total angular momentum and parity, S is quark spin. Compare with the experimental review by D. Mark Manley. (You may have to print this paper as an image.)