Physics 224 **Fall 1999**

Phenomenology **due 11:00 am Tuesday Nov. 16**

PROBLEM SET 7

November 11 Colloquium: "Exotic Quantum Effects in Low Dimensional Antiferromagnets"

Prof. Ian Affleck, University of British Columbia

3:30 pm, 101 Rowland Hall

1. On a separate sheet of paper (with your name), name the topic of your report (try to be specific) and list the reference(s) you will use for your final report.

2. Eisberg and Resnick Problem 13.18.

3. Eisberg and Resnick Problem 13.24.

4. Eisberg and Resnick Problem 13.30 (n-p-n transistor).

5. How many different meson combinations can you make with 1, 2, 3, 4, 5, or 6 different quark flavors? What's the general formula for n flavors?

6. How many different baryon combinations can you make with 1, 2, 3, 4, 5, or 6 different quark flavors? What's the general formula for n flavors?

7. The mass formula for decuplets of baryons assumes equal spacing between the rows:

$$M_\Delta - M_{\Sigma^*} = M_{\Sigma^*} - M_{\Xi^*} = M_{\Xi^*} - M_\Omega \tag{1}$$

Use this formula (as Gell-Mann did) to predict the mass of the Ω^-. (use the average of the first two spacings to estimate the third.) How close is your prediction to the observed value? (See attached table of masses.)

8. In the period before the discovery of the neutron many people thought the nucleus consisted of protons and electrons, with the atomic number equal to the excess number

of protons. Beta decay seemed to support this idea–after all, electrons come popping out; doesn't that imply that there were electrons inside? Use the position–momentum uncertainty relation, $\Delta x \Delta p \geq \hbar$, to estimate the minimum momentum of an electron confined to a nucleus (radius 10^{-13} cm). From the relativistic energy–momentum relation, $E^2 - p^2c^2 = m^2c^4$, determine the corresponding energy, and compare it with that of an electron emitted in, say, the beta decay of tritium (a hydrogen atom with one proton and 2 neutrons) (see attached figure). (This result convinced some people that the beta–decay electron could *not* have been rattling around inside the nucleus, but must be produced in the disintegraion itself.)