Physics 224 **Fall 2000**

Discoveries and Inventions of Modern Physics **due 11:00 am Tuesday Nov. 21**

PROBLEM SET 8

Nov. 16 Colloquium: "Reactions at Air-Water Interfaces in the Atmosphere: The New Frontier in Atmospheric Chemistry"

Prof. B. Finlayson-Pitts, UC Irvine

3:30 pm, 101 Rowland Hall

Final Project

Reports on final projects will be given on Tuesday December 5 from 10:30 am to 12:30 pm. Your oral presentation should be 12 minutes long plus 3 minutes for questions (15 minutes total). You may use the blackboard or transparencies in your presentation. In addition you should hand in a written report that is 2 to 3 pages long.

Problems

1. 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?

2. 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?

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

$$M_\Delta - M_{\Sigma^*} = M_{\Sigma^*} - M_{\Xi^*} = M_{\Xi^*} - M_\Omega \qquad (1)$$

   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.)

4. 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.)