**Class #05 (Feb. 8) Reading Questions - Cosmic Onion, Chapt. 7**

**Summary:** Chapter 7 presents the theory of the strong interaction, known as quantum chromodynamics or QCD. The term "chromo" refers to the property color invented in 1964 to explain why the Pauli exclusion principle does not forbid the existence of baryons with 3 identical quarks. Three colors were required to make Gell-Mann's quark model for the known hadrons consistent with Pauli exclusion. This new color property suggested a theory of the strong interaction analogous to Feynman's theory of the electromagnetic interaction, known as quantum electrodynamics or QED. In QED we have one electric charge (with plus/minus versions) and the electromagnetic interaction is carried by the photon (a zero mass, spin 1 object). In QCD we have three color charges (red, yellow, blue each with color/anticolor versions) and the strong interaction is carried by the gluon (a zero mass, spin 1 object). An added complication to the strong force is that the gluons themselves carry color charge and thus also interact strongly. Experimental evidence for the existence of 9 different quark types (3 flavors x 3 colors) was obtained in the early 1970's giving support to the theory of color. By the way, most of the literature names the colors red, green, and blue.

**Questions:**

1. Without the color property, the Pauli exclusion principle would only allow the existence of one of the ten spin 3/2 baryons (see Fig. 6.3). Which one would be allowed and why? Why would the others all be forbidden?

2. Color plays a role analogous to electric charge. Explain how the 3 (really 6) different versions of the color charge interact.

3. In QCD the gluons also carry color charge ... in fact they are "bi-colored" carrying both a color and an anti-color (for example, there is a red-anitred gluon). List all possible color combinations for the gluons. How many are there?

4. What is a hadron jet? Why are these jets usually observed in pairs oriented back-to-back?

5. Explain how the strong interaction depends on quark-quark distance. What does the term "asymptotic freedom" refer to?

**Your Question:** Please give a well-formulated question that you have regarding the material covered in this reading assignment.