Class #04 (Feb. 1) Reading Questions - Cosmic Onion, Chapt. 6

Summary: Chapter 6 introduces the quark model, proposed independently by Gell-Mann and Zweig in 1964 to explain the 8-fold way organization scheme for hadrons. In this model there are three quarks called up, down, and strange with charges +2/3, -1/3, and -1/3, respectively. The quarks all have spin 1/2 and combine into two or three particle combinations as follows: meson = quark plus antiquark (note the typo in Table 6.2), baryon = three quarks (anti-baryon = three antiquarks). These combinations give the observed baryon octet and decuplet but predict that the mesons should come in groups of 9 (a nonet rather than an octet). The eta-prime meson, which was known but did not fit into the 8-fold way scheme, was now recognized as the ninth member of the spin zero meson nontet. The discovery of a complete nonet of spin 1 mesons provided support for the quark model. However, the model seemed to have an obvious and perhaps fatal flaw ... no one had ever seen a fractionally charged particle. This led many physicists to be skeptical of the reality of quarks. However, a set of scattering experiments at the Stanford Linear Accelerator (SLAC) in the late 1960's showed convincingly that the proton has an inner structure. Kendall, Friedman, and Taylor were awarded the Nobel prize in physics in 1990 for this work. Kendall and Friedman taught me freshman physics at MIT in 1978 (so I knew them before they were famous!).

Questions:

1. Explain how the quark model naturally leads to spin 0 and 1 mesons and spin 1/2 and 3/2 baryons.

2. In the quark model is it possible to have a baryon with charge = -2 or strangeness = 1? Is an antibaryon with either of these properties possible? Is it possible to have a meson with charge = +2? Please provide some explanation for each case.

3. If there are only 3 quarks, how is it that we now identify hundreds of hadrons rather than just the original 18 baryons and 18 mesons?

4. Explain how the scattering experiments at SLAC provided direct experimental evidence for the reality of quarks even though an isolated quark was not seen. What else did this these experiments provide evidence of?

5. Where does the name "quark" come from?

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