Class #03 (Jan. 25) Reading Questions - Cosmic Onion, Chapt. 5

Summary: Chapter 5 really begins our introduction to modern particle physics, starting with Anderson's discovery of the muon in 1936 and Powell's discovery of the pion in 1947. The pion had been predicted by Yukawa in his theory of the strong interaction, so its discovery was not a complete surprise; the muon, however, which acts like a heavy version of the electron, was completely unexpected. Improved particle detectors and particle accelerators led to the discovery of more particles including a set that came to be known as "strange" particles. To understand the various ways these short-lived strange particles decayed, theorists proposed a new quantum number similar to charge or spin, known as strangeness. During the 1950's a large number of new particles were discovered and theoretical physicists were unable to make sense of these findings. It was felt that there should be some simplicity in describing the fundamental constituents of nature and yet the experimental results looked increasing complicated as new members of the growing "particle zoo" were discovered. Finally, in 1960 Gell-Mann and Ne'eman each showed that the known hadrons could be arranged into patterns based on particle type (meson or baryon), charge, and strangeness. Although the exact meaning of this organizational scheme (the eight-fold way) was not clear, Gell-Mann was able to predict the existence of a particle that was missing from the pattern for spin 3/2 baryons (which he called the Omega-minus). Discovery of the Omega-minus particle in 1963, with the exact properties predicted by Gell-Mann, gave credence to this organizational structure (which many compared to Mendeleev's original periodic table of the elements).

Questions:

1. Define the terms lepton, hadron, baryon, and meson. Be clear about what distinguishes a baryon from a meson

2. What unusual property originally gave rise to the term "strange" particle?

3. a) Explain why pi-minus + proton -> Kaon-0 + Lambda-0 is "allowed" ... but ...
pi-minus + proton -> Kaon-0 + neutron is "forbidden".

b) Explain why Kaon-0 -> pi-plus + pi-minus is "allowed" ... but ...
Kaon-0 -> proton + pi-minus is "forbidden".

4. Explain why one might assume the Lambda particle should be stable. How do we explain the fact that it is not stable?

5. From his 8-fold way patterns Gell-Mann predicted the existence of the Omega-minus particle. Explain how Gell-Mann was able to predict the mass of this undiscovered particle? Why would knowing the mass be important for an experimentalist trying to create this particle?

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