

Class #11 (Mar. 28) Reading Questions - Cosmic Onion, Chapt. 13

Summary: The standard model of particle physics is a comprehensive and well-tested theory of the basic constituents of nature and the interactions between them. With the recent (2012) discovery of the Higgs boson, all of the pieces of the model have been verified. Despite the great success, most physicists are not completely satisfied with the standard model and believe that it is really just a "low-energy" approximation to a simpler, more exact theory. The overall organization of the standard model, with repeated generations of quark/lepton pairs and common interaction strengths across the generations, suggests some deeper structure. Grand-unified theories (GUTS) propose that the three interactions of the standard model arise from a single "strong-electroweak" interaction. Most of these theories introduce a new symmetry property into the standard model that relates the fermion (quark and lepton) and boson (force carrying) constituents. This new supersymmetry or SUSY predicts that every particle in the current standard model should have a "supersymmetric" partner particle. Many physicists thought that some of these SUSY particles would be found once the LHC began operation in 2009, however, thus far none have been observed. Despite the lack of experimental evidence, SUSY seems so compelling that particle physics has not given up on it and the search for new particles continues.

Questions:

1. In what ways are the quark and lepton pairs of the SM similar to each other? How might the three color charges of QCD be related to the single electric charge of QED?
2. Symmetry operations involve doing something to a system that leaves the system unchanged. What is the symmetry operation that defines SUSY?
3. One prediction coming out of SUSY is that protons should decay (and the original Kamiokande experiment was built to look for this). Why is the proton not an infinitely stable particle in SUSY?
4. Explain what is shown in Fig. 13.1 and how SUSY helps with grand-unification.
5. What is the connection between the Higgs boson (or Higgs Field) and particle mass?

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