

Class #02 (Jan. 18) Reading Questions - Cosmic Onion, Chapt. 3-4

Summary: Chapter 3 describes some of the early investigations into the structure of the nucleus leading to Chadwick's discovery of the neutron. Fermi produced new isotopes of many elements by exposing them to slow moving neutrons and Hahn and Meitner used slow neutrons to split the uranium nucleus, a process that can lead to a chain reaction. The strong interaction holding protons and neutrons together in the nucleus can explain both alpha and gamma radiation, but beta radiation was different, suggesting a new type of nuclear interaction (and a new mysterious particle). This chapter ends with a discussion of the formation of the heavy elements in a supernova. Chapter 4 gives an overview of the four forces of nature including simple descriptions of Feynman's model for the electromagnetic interaction (QED) and Yukawa's early model for the strong interaction. Also included are some details about the weak interaction ... but you can skip these for the moment, we will be getting to them later in the course.

Questions:

1. Explain Chadwick's experimental evidence for the neutron. Did he actually "see" or directly detect a neutron?
2. What were the experimental results that led to Pauli's prediction of the neutrino?
3. Why do the naturally occurring elements found on earth end with uranium?
4. In QuantumElectroDynamics (QED) the electromagnetic interaction is produced (or mediated) by the exchange of virtual photons between charged particles, as illustrated in the Feynman diagrams on pg. 52. Yukawa used this exchange idea to construct an early model of the strong nuclear interaction. The strong interaction has a range of only 10^{-14}m (while the electromagnetic interaction has infinite range). Explain how Yukawa was able to build this very short interaction range into his theory.
5. According to Close, by 1932 it was believed that the fundamental building blocks of matter were the electrons, protons, neutrons, and neutrinos. Which of the four forces of nature do each of these particles feel?

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