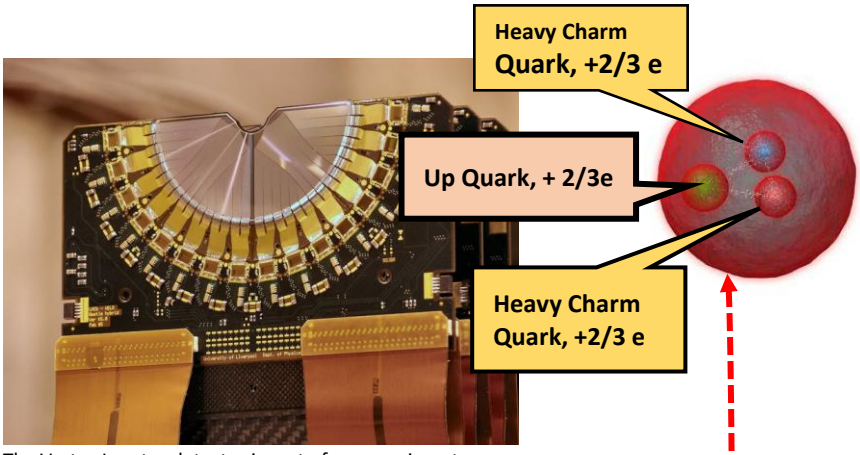
ENERGY & MASS

Unit 10 & 11 Dr. John P. Cise, Professor of Physics, Austin Com. College, Austin Tx. , jpcise@austincc.edu & New York Times , July 6, 2017 by Kenneth Chang

CERN Physicists Find a Particle With a Double Dose of Charm



The Vertex Locator detector is part of an experiment at CERN's Large Hadron Collider that discovered a particle that contains two charm quarks

Physicists have discovered a particle that is doubly charming.

INTRODUCTION: 1.:CERN in Geneva measured Xi-cc++ mass as 3621 Mev/c^2. Wikipedia states: mass of proton is 938.272 Mev/c^2,mass of heavy charm quark is 1.29 Gev/c^2, mass of up quark is 2.3 Mev/c^2. Down quark mass is 4.8 Mev/c^2, Xi-cc++ charge is +2e

QUESTIONS: (a) Show mass of Xi-cc++ is 3.8 mass of proton as stated?,(b) Show Mass of heavy charm quark is 570 mass of Up quark?,

ANSWERS: (a) [3.8] X [938.272 Mev/c^2] = 3.565 Gev/c^2, close! (b) [570]x[2.3 Mev/c^2 = 1.311 Gev/c^2, close!

Researchers reported on Thursday that in debris flying out from the collisions of protons at the CERN particle physics laboratory outside Geneva, they had spotted a particle that has long been predicted but not detected until now.The **new particle, awkwardly known as Xi-cc++ (pronounced ka-sigh-see-see-plus-plus),** could provide new insight into how tiny, whimsically named particles known as quarks, the building blocks of protons and neutrons, interact with each other.

Protons and neutrons, which account for the bulk of ordinary matter, are made of two types of quarks: up and down. A proton consists of two up quarks and one down quark, while a neutron contains one up quark and two down quarks. **These triplets of quarks are known as baryons.** There are also heavier quarks with even quirkier names — strange, charm, top, bottom — and baryons containing permutations of heavier quarks also exist. An experiment at CERN, within the behemoth **Large Hadron Collider, counted more 300 Xi-cc++ baryons, each consisting of two heavy charm quarks and one up quark.** The discovery fits with the Standard Model, the prevailing understanding of how the smallest bits of the universe behave, and does not seem to point to new physics. "The existence of these particles has been predicted by the Standard Model," said Patrick Spradlin, a physicist at the University of Glasgow who led the research. "Their properties have also been predicted." Dr. Spradlin presented the findings on Thursday at a European Physical Society conference in Venice, and a paper describing them has been submitted to the journal Physical Review Letters. **Up and down quarks have almost the same mass, so in protons and neutrons, the three quarks swirl around each other in an almost uniform pattern. In the new particle, the up quark circulates around the two heavy charm quarks at the center. "You get something far more like an atom," (((The mass of the Xi-cc++ is about 3.8 times that of a proton.)))** The particle is not stable. Dr. Spradlin said the scientists had not yet figured out its lifetime precisely, but it falls apart after somewhere between 50 millionths of a billionth of a second and 1,000 millionths of a billionth of a second. For Dr. Rosner, the CERN results appear to match predictions that he and Marek Karliner of Tel Aviv University made.

What gives protons mass? The strong force and you. The Higgs field gives mass to fundamental particles—the electrons, quarks and other building blocks that cannot be broken into smaller parts. ... (((The energy of this interaction between quarks and gluons is what gives protons and neutrons their mass.)))

INTRODUCTION 2: The proton, as stated above, is made up of two up quarks and one down quark.

QUESTIONS: (a) With the information above on mass of up and down quark, find mass of proton based on stated mass of up and down quarks?, (b) Find differential between the mass you found in (a) and stated mass of a proton? (c) Read what is in box at left. Explain where the missing mass is located?

ANSWERS 2 : (a) 9.4 Mev/c^2 , (b) 928.9 Mev/c^2 is missing mass, (c) (((The energy of this interaction between quarks and gluons is what gives protons and neutrons their mass.)))