Glasgow scientists predict mass of new particle

January 26 2010

(PhysOrg.com) -- A team of physicists from the University of Glasgow has predicted the mass of a new particle which would help explain one of the fundamental forces of the universe.

The scientists say the B_c* meson will have been produced fleetingly in collisions in the Tevatron accelerator in Illinois, USA and at CERN in Switzerland, but has not yet been spotted by experimentalists searching through the debris.

However, a team led by Professor Christine Davies, head of the University's Particle Physics Theory Group in the Department of Physics and Astronomy, and an expert in Quantum Chromodynamics (QCD) theory, used supercomputers to predict the mass of the meson, which might help scientists understand the strong force that dictates the behaviour of particles at the sub-atomic level.

The strong force is one of the four fundamental forces of the universe and is what holds quarks together - the smallest units of matter found to date. It is this force that QCD theory seeks to understand.

The other fundamental forces are:

* Gravitation - the phenomenon where bodies of mass are attracted to each other,
* Electromagnetic - the attraction that exists between electrically charged particles such as electrons and protons,

* Weak - which is involved in some forms of particle decay, most notably nuclear beta decay

Prof Davies said: "Although this meson has not yet been shown to exist, our calculations have allowed us to predict not only its existence but also its mass. Two previous predictions we've made have been shown to be true so we are confident with this one. We predict the mass of the particle to be 6.330 GeV/c^2 with an error of 9 MeV/c^2. This is 6.75 times the mass of the proton with an error of 1% of the proton's mass. We predict that this particle is heavier than its cousin the B_c (whose mass we predicted five years ago) by 53(7) MeV/c^2."

Quarks come in six varieties (or flavours, as they are known) - up, down, charm, strange, top and bottom. Quarks all have color charge, which is similar to electric charge and causes them to feel the strong force and they also all spin. They differ very much in mass, however - up quarks have a mass a few times that of an electron whilst top quarks are nearly as heavy as a lead nucleus.

Quarks are never found in isolation, however, because the strong force is so powerful that it would take an infinite amount of energy to separate them. Instead they are always found together - in pairs (meson) or threes (baryon) - as particles called hadrons. Protons and neutrons, the particles which make up the nuclei of the atoms in the elements on the periodic table, are examples of hadrons.

The B_c* meson comprises a bottom quark and a charm antiquark in a configuration in which the quark spins are pointing in the same direction.

Understanding how quarks interact as a result of the strong force helps scientists to connect this knowledge to that of the mesons they see in experimental situations.

Prof Davies said: "The HPQCD collaboration specialises in accurate calculations of the properties of the 'particle zoo' of mesons using the theory of the strong force (QCD), and uses these calculations to determine the properties of quarks. The calculations must be done on very powerful computers, because the strong force is so powerful that it leads to very complicated interactions."

The team at Glasgow is currently working on producing predictions based upon incredibly complex calculations for a variety of different types of particles which can then be compared to the results of experiments at CERN's LHC project.

The knowledge can then be used, it is hoped, to expose gaps in the Standard Model of physics, the theory which attempts to explain what the universe is and how it functions.

More information: Prediction of the Bc* Mass in Full Lattice QCD, link.aps.org/doi/10.1103/PhysRevLett.104.022001

Provided by University of Glasgow

Citation: Glasgow scientists predict mass of new particle (2010, January 26) retrieved 12 May 2024 from https://phys.org/news/2010-01-glasgow-scientists-mass-particle.html