What is a boson?

What is a boson? Where does mass come from? How are electrons and protons fundamentally different? Read on to have all these questions and more answered

By George Watson
Wednesday 23 October 2013

Peter Higgs

Peter Higgs won this year's Nobel Prize in Physics following the discovery of his eponymous boson, the name of which is universally familiar. But what is a boson?

A physicist might tell you that it's a particle with integer spin that can occupy the same quantum state as an unlimited number of other bosons, but that isn't very useful.

In hopefully more useful terms, particles are divided into two groups.

The first, fermions (named for 20th-century Italian physicist Enrico Fermi, who holds the dubious title "father of the atomic bomb"), make up all of the matter in the universe, from stars to the chair you're sitting on — and, indeed, the bottom you're sitting on it with.

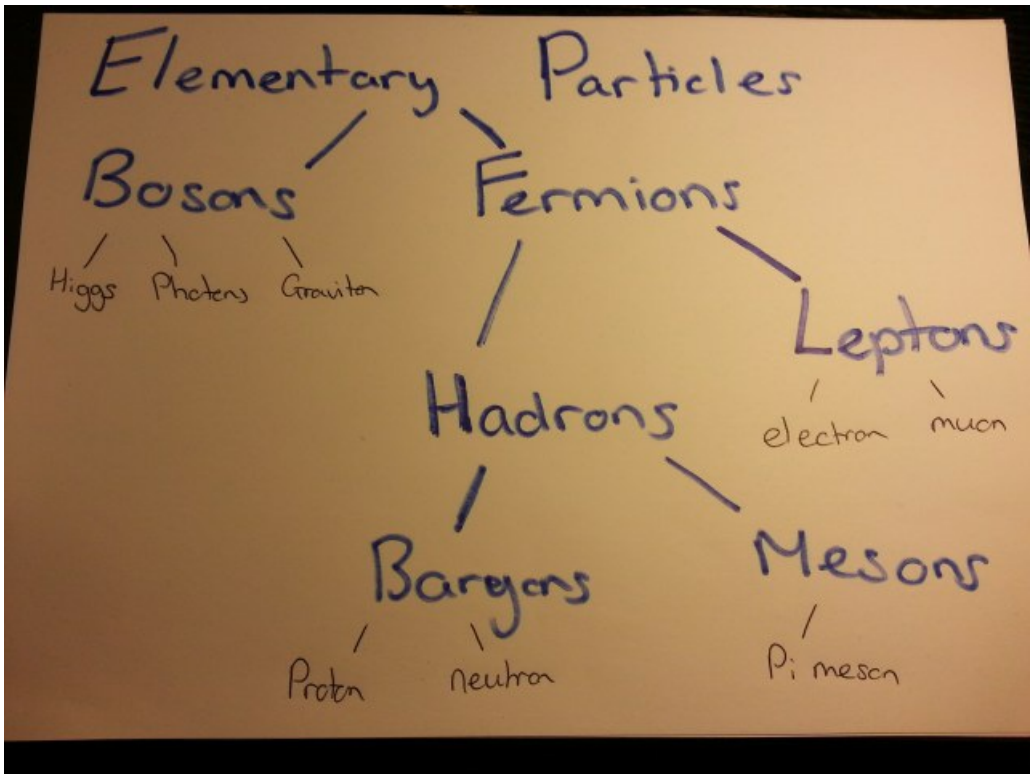
Meanwhile, bosons (named for 20th-century Indian physicist Satyendra Nath Bose) include the particles responsible for all of the interactions between this matter (and also a lot of more complicated composite particles, including around 60% of atomic nuclei, but we can ignore those for now).

But because particle physics isn't usually too fond of simplicity, fermions can be further divided into two groups: leptons and hadrons. The difference the two is that hadrons are made up of quarks whereas leptons are not.

Quarks come in six varieties (or 'flavours') with some strange and charming names, and like to band

together in threesomes to form more familiar things like protons and neutrons, the building blocks of atomic nuclei. A particle made up of 3 quarks is called a baryon, whereas it is called a meson if it consists of only 2 quarks.

Leptons are less complicated, and also much lighter. Indeed, you've probably already heard of electrons and neutrinos, another particle that's been in the news a lot recently. The electron's lesser-known cousins, the muon and the tau, and a corresponding neutrino each, complete another neat set of six, of which only the electron is particularly useful if you want to make stars, chairs, or bottoms.



Elementary particle breakdown

We now have a universe full of stuff, sitting around and not doing very much. There's not really very much it *can* do at the moment. Let's make our universe a little less dull by adding some bosons.

Three of the four fundamental forces (electromagnetism and the strong and weak nuclear forces, the exception being gravity, which is the elephant in the room for professional physicists) can be explained as a result of the interactions of particles with bosons that are known to exist — these bosons are known as the gauge bosons.

Electromagnetism, which not only makes magnets and light bulbs work, but also holds atoms together and stops us from going right through everything we touch, is the result of interactions with photons, tiny individual packets of light.

The strong nuclear force holds quarks together in their neat threesomes, through the transfer of aptly-named gluons, while the weak nuclear force causes radioactive decay thanks to W and Z bosons.

The Higgs, despite its fame, is a rather lonely particle, currently alone in the group of scalar bosons. Interactions with the Higgs are the reason particles have mass, and understanding this superficially simple property is the reason it's such a big deal.

5 comments

confused, v. 23 Oct ’13 at 4:30 pm

wat about quarks

Report

George 23 Oct ’13 at 7:06 pm

@confused, v.

Quarks are included somewhere around the middle of the article:
“Quarks come in six varieties (or ‘flavours’) with some strange and charming names, and like to band together in threesomes to form more familiar things like protons and neutrons, the building blocks of atomic nuclei. A particle made up of 3 quarks is called a baryon, whereas it is called a meson if it consists of only 2 quarks.”

Is there any particular part that confuses you?

Report

Russell Chihoski 22 Sep ’14 at 6:53 pm

Photons (and proper bosons) travel at c only. Theu are –as Bohms says– discrete EMF pulses. We should stop calling them particles. Now I hear there are bosons that are masses which cannot reach c. Those cannot be bosons. Something is wrong here. What is it. The definition of boson? RAC

Report

Harsh gupta 1 Jul ’15 at 2:19 pm

This is real or not

Report

Harsh gupta 1 Jul ’15 at 2:25 pm

My teacher say that Bosons is the part of atom so it is posible that it is used to save a person

Report

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