Concerning CERN: Cliff Burgess on the discovery of the Higgs boson

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(Phys.org) -- If you're a little confused by the news that scientists at the European Organization for Nuclear Research, better known as CERN, may have found the Higgs boson, you're probably not alone. Theoretical particle physics isn't the easiest topic to understand.

With the help of Cliff Burgess, himself a theoretical particle physicist and professor of physics and astronomy who has spent time working at CERN, we attempt to better understand the organization's findings.

In layman's terms, can you explain what exactly has been discovered at CERN?

They have found the first experimental evidence for the existence of a new elementary particle, the Higgs boson, which seems to verify a radical theoretical proposal that was made back in the 1960s.

Normally we think of the vacuum as just being the thing that has nothing in it. But Peter Higgs, and others, proposed instead that the vacuum is a physical thing which has physical properties, with which elementary particles can interact. There is an energy associated with this interaction, which we interpret as the particle mass due to Einstein's relation E=m c^2.

At CERN they have just provided the first experimental evidence that this picture of the vacuum having physical properties is right. They did

so by exciting a wave in the vacuum, which in their experiment looks like a new type of particle.

Can you elaborate on just what the so-called "God particle" is?

First off, everybody in the business calls it the Higgs particle and cringes just a bit when it is called the "God particle". What makes it important is that it shows that there are waves in the vacuum.

You can think of the whole picture as an analogy where elementary particles are replaced by fish.

Suppose you were interested in the properties of fish and how they move and why some fish move faster than others given the same amount of effort. This would be very hard if you did not understand what water was.

In order to understand properly the motion of fish, you must first also understand the environment through which they move.

Now, those who study fish never doubted the existence of water because, unlike the fish, scientists do not live in it. If you were the first to propose that water existed, it might be a harder sell since everyone would take it for granted. The acid test would be to move the water, or to excite a water wave, since that would show that there was something "there" besides just fish.

So the radical theoretical proposal is that we are all moving through a medium, and it is the properties of this medium that partially control the behaviour of elementary particles. Again the acid test is to perturb the vacuum and excite a wave in it. This is what the experiments at CERN

seem to have done for the very first time.

Why is this discovery important?

It is important because the assertion that the vacuum has physical properties is a very radical idea.

We have a very successful theory called the Standard Model, which has a particular take about what the vacuum's properties are. But there are other theories as well, and these differ on what the vacuum is like, and so also differ about what kinds of waves (or Higgs particles) can be excited.

Having discovered these waves, we can now explore their properties to see which of these theories is right.

Will this change anything for the average person?

In some ways, the experiments that found the Higgs already have. One of the challenges the experimenters faced in the early 1990s was how to plan to analyze all of the data that this experiment would produce.

To solve it, scientists at CERN (building on the previously built internet) developed the world wide web as a simple way for experimenters to deal with data around the world, just by clicking on things with a mouse. It is this software that made the internet into something the public could use, and has transformed our lives ever since.

As always with curiosity-driven science, it is very difficult to know what the spin-offs will be before they arise.

Probably the most important spin-off we do know about is people. The

economy is full of people with mathematical problem-solving skills, from mathematical bankers to computer programmers and engineers. Many of these learned these skills because they were drawn by the cool ideas in particle physics (or astronomy or other areas of mathematical sciences). These people have a huge impact on our everyday lives because they are of huge value to the economy as a whole.

Where does this rank in terms of scientific discovery?

Experimental evidence that the vacuum has physical properties is among the biggest discoveries we can have. Unfortunately, this is not the reason most of the media convey when they provide the attention. So I would say the attention is justified, but the media is not doing a very good job explaining why.

Will your own research be impacted by CERN's findings?

I have my own theory for what the vacuum is like, and so have predictions for what the CERN experiments should be seeing over the next few years. Most of my work involves exploring the implications of this theory, both for CERN experiments and for cosmology (the history of the universe as a whole). So far my theory is doing pretty well (in my opinion), so things are looking good!

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