UC SANTA BARBARA

THE Current

July 5, 2012
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‘Observation of New Particle' Presented at Historic CERN Seminar by UC Santa Barbara Professor Joe Incandela

The observation of a new particle that appears to be the long sought-after Higgs boson was presented at a seminar at the European Organization for Nuclear Research (CERN) on July 4 by UC Santa Barbara physics professor Joe Incandela, who is also the spokesperson for the Compact Muon Solenoid (CMS) experiment at CERN.

"We have observed a new boson," Incandela said, to the applause of hundreds of scientists and students attending the seminar, which was broadcast live via a webcast around the world. Evidence for the new particle is very strong, he said, and the pattern seen across the different observations is consistent with the theoretical predictions for the Higgs boson. "This is a preliminary report, but we think it's very strong and very solid," Incandela said.

A "Holy Grail" of particle physics, the Higgs boson is a rare particle, sought after because it is crucial for explaining why most of the fundamental particles of nature have mass. The boson is named after Peter Higgs, one of several theoretical physicists who predicted its existence some 50 years ago. Higgs attended the announcement in Geneva.

"We have now found the missing cornerstone of particle physics," Rolf Heuer, director of CERN, told the scientists. "We have a discovery. We have observed a new particle that is consistent with a Higgs boson."

There are still many more questions to answer, Incandela emphasized. Although there are strong signs pointing to the Higgs, more data will be needed to establish that the new particle has all of the properties predicted for the Higgs boson, including that the particle must have an angular momentum –– a "spin" –– of zero. CMS should be able to start addressing these questions by the end of the 2012 data-taking run.

Thanks to the high energies of the Large Hadron Collider, the world's largest particle accelerator, new vistas in particle physics have been opened. The new particle was produced multiple times in collisions between two beams of protons colliding in opposite directions in the LHC. The combined energy of two such protons colliding is the equivalent to that of 8 trillion one-volt batteries. Using Einstein's formula for mass-energy equivalence (E = mc2), part of this energy was converted, through quantum processes, into the mass of the new particle.

The mass of the particle is roughly 130 times the mass of the proton, Incandela explained. It has taken so long to discover the particle because only a tiny fraction of the collisions produced the particle and CMS was able to disentangle only some of them from the many other processes occurring during the collisions.

Many physicists had anticipated the results, and the excitement has been building around the world for months. "The number of collisions that CMS observes (in which this new particle appears) is pretty much what everyone expected for a Higgs boson," said David Stuart, professor of physics and member of the High Energy Physics group at UCSB. "It seems to have arrived on schedule."

"This is an historic moment in particle physics," said Michael Witherell, UCSB vice chancellor for research. "We are very proud that Joe and the UCSB High Energy group have been so deeply involved in the CMS project."

The group includes professors Claudio Campagnari, Jeffrey Richman, Stuart, and Incandela. Additionally, three senior engineers –– Susanne Kyre, Dean White, and Guido Magazzu –– are part of the group, as well as some 20 postdoctoral, graduate, and undergraduate students.

"Hearing our colleague Professor Joe Incandela announce this discovery to the world was an unforgettable moment," said UCSB Chancellor Henry T. Yang. "I extend my sincere congratulations to him and to our entire UC Santa Barbara team –– including our students –– for their fundamental contribution to our scientific understanding of the universe. We are proud to be part of this extraordinary international collaboration, and we look forward to many more exciting discoveries and breakthroughs ahead."

The UCSB team has made many contributions to the construction of the highly complex CMS, which is about the size of a four-story building and weighs 14,000 tons. The group played a strong role in constructing the high-precision particle tracking system, which is used to map the trajectories of particles created in the collisions. The engineers, along with an army of postdocs, graduate, and undergraduate students, helped to assemble components for the silicon particle tracker in clean rooms on the UCSB campus. Other members helped write the vast amount of software used to process and analyze the data. Postdoc Dmytro Kovalskyi played a key role in leading the efforts of a broad team on one of the search channels.

"Many of the graduate and undergraduate students who helped to build the CMS particle tracking system have graduated and have gone on to other institutions or to industry," said Campagnari. Quite a few, he added, also work on ATLAS, another particle detector at LHC.

"It is remarkable that a huge, international collaboration can work so well under tremendous pressure," said Richman. "Roughly 2,000 physicists and students work on the experiment, coming from nearly 200 scientific institutions. From constructing and operating the experiment to analyzing the data, this has been a monumental effort, and we have great scientific colleagues from all over the world."

Richman, who was at CERN, added: "I have not seen particle physicists this excited in over 30 years. People were cheering, and there were standing ovations. It was great that Peter Higgs and other theoretical colleagues, whose profound insights have guided our field, could be here to share in this rare moment of discovery."

These results are only the beginning, Incandela emphasized. The results of the experiments at CMS and ATLAS open the way for many more studies to fully understand the nature of the particles that have been found. For instance, in one set of scenarios known as "supersymmetry," there can be multiple Higgs bosons, as well as many additional particles of nature. One of these additional particles could theoretically account for the so-called "dark matter," an invisible type of matter inferred by astrophysicists from its gravitational effects on visible matter, such as stars. Dark matter is now known to account for most of the matter in the universe. Searching for the additional particles predicted by supersymmetry is another of the LHC's missions and a particular area of activity at UCSB.

"The combined results from CMS and ATLAS are very convincing," Incandela said after the seminar. "This is a landmark event for fundamental particle physics."

The UCSB High Energy Physics effort on CMS is supported by the U.S. Department of Energy.

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† Top image: A portrait of part of the UCSB team at CERN, from left, professor Claudio Campagnari, engineer Guido Magazzu, professor David Stuart, professor Joe Incandela, and professor Jeff Richman.

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