- Photo by Ryan Slabaugh

Aspen Times Weekly cover story: What in God's name is Higgs boson?

Higgs Boson discovery proves the best gift for the Aspen Center for Physics' 50th birthday

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ASPEN — It was standing room only in the auditorium of the Aspen Center for Physics on a recent Friday evening as Elizabeth Simmons, professor of Physics at Michigan State University, tried her best to explain what all the hype was over the European Center for Nuclear Research's July 4 announcement of the Higgs boson — more fancifully called the "God particle" by the thousands of scientists who have searched half a century to find it.

An achievement that has perhaps finally given merit to CERN's $9 billion underground Large Hadron Collider constructed back in 2008 in Geneva, the discovery of the Higgs boson, according to Simmons, serves as the missing link to the Standard Model, or what we understand as the explanation for the behavior of subatomic particles in the universe.

Here in Aspen, the announcement from CERN headquarters couldn't have come at a better time, especially when hundreds of physicists from all over the country were already gathered at the physics center for their annual summer retreat — collaborating with colleagues and expanding their fields of research through informal group discussions, seminars and workshops. And when The New York Times reported that bleary-eyed physicists in Aspen drank champagne through the wee hours as the report came via webcast on the Fourth of July, the reality of just how large this discovery means to all of science certainly got the rest of our heads turning.

"So what is a Higgs boson anyway?" Simmons proposed to the silent crowd in the physics center's Flug Forum.

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Making sense of the discovery via metaphor-driven slides and analyzed data results from CERN, Simmons explained that while the Standard Model provides insight into the fundamental structure of matter by breaking down our universe into 12 basic building blocks called "fundamental particles" that are governed by four fundamental forces, it is missing crucial elements that explain how some particles acquire mass and others remain weightless.

In an attempt to find the missing link for the model, a man named Peter Higgs and five other scientists in the 1960s developed a model for the existence of a particle named after Higgs called the Higgs boson, which, if it existed, would explain why directly after the Big Bang, stuff came into existence that wasn't there before.

As illustrated by Simmons, the Higgs boson is the particle that we have seen, and exists as part of a bigger entity called the Higgs field, which has several different aspects to it that perform different jobs.

“The Higgs field pervades the entire universe like fish swimming through a great lake,” she said. “As the fish swim, the presence of water provides a certain amount of drag on the fish, just as the Higgs field provides a certain amount of drag on particles. The more the particles interact with the field, the more they are slowed down … the more inertia and mass they have.”

Nonetheless, scientists have struggled for years trying to pick up on such an unimaginably tiny particle that is ironically a monster in the subatomic world. But after billions of collisions between protons within the airless Large Hadron Collider in Geneva — an engineering masterpiece that sits 100 meters underground and holds rings 27 kilometers around — scientists were able to trace the debris of the collisions at two separate points and find very similar results.

“There was the probability question of whether what scientists saw was actually the Higgs or just noise,” Simmons explained, “but the results were quite obvious, showing a 5 sigma signal, fitting the gold standard for declaring a discovery.”

The response upon seeing CERN's groundbreaking data for the first time was a staggering gasp heard among scientists from here to Europe.

But the bigger question, posed by a handful of speculative listeners packed into the auditorium, was “What comes next?”

Fortunately for CERN, the Large Hadron Collider will not reach its maximum collision energy until the year 2015, allowing scientists room for further analysis on the properties of what they did find and experimentation for other big questions like what makes up dark matter.

In the meantime, the couple hundred physicists gathered here in Aspen share excitement across the field as they not only relish over the Higgs but also celebrate the center's 50th anniversary with birthday parties, public lectures and special events.

Lawrence Krauss, a theoretical physicist in cosmology and particle physics at Arizona State University and author of “A Universe From Nothing: Why There is Something Rather than Nothing,” has been joining the Aspen Center for Physics' retreat for more than 30 years and expressed his reaction to the Higgs findings.

“I suppose I did have an antagonistic view toward the theory over the years,” he said, “but the findings do describe what I talk about in my newest book — that space is permeated by an invisible field. This makes empty space more important than ever imagined, and I hope that in the years to follow we can develop more clues to understand the fundamental structure of matter.”

Catherine Kallin, professor of physics and astronomy at McMaster University in Ontario and fellow of the Canadian Institute for Advanced Research program in quantum materials, noted that unifying concepts of the Higgs connect all fields of study and that sharing the announcement with everyone at the Aspen Center for Physics made it even more worthwhile.

“Science is such an international endeavor,” Kallin said. “It is nice to know that Aspen as a community stands out with a deeply rooted curiosity in the field that goes beyond the work we do as researchers.”

And while the primary purpose of the retreat revolves around stimulating ideas for discovery and new work, physicists also set aside time to indulge in the endless summer activities Aspen offers.

“They give us a bike and a place to stay,” said Edward Farhi, director of the Center for Theoretical Physics at MIT and active researcher in the field of quantum computing. “I bring my whole family and enjoy the area by hiking, biking and meeting up with friends.”

As the summer moves forward, and the center celebrates 50 strong years of advancing the forefront of knowledge in physics throughout not only our community but the country, the Higgs boson discovery will play a crucial part in our

future understanding of the phenomena of the universe and make us proud to share the national milestone so close to home.

But like The Guardian's Elizabeth Simmons suggested in response to the question “What's next?” posed during her dialogue on July 6, “now that we've found the Higgs, the real work begins.”
