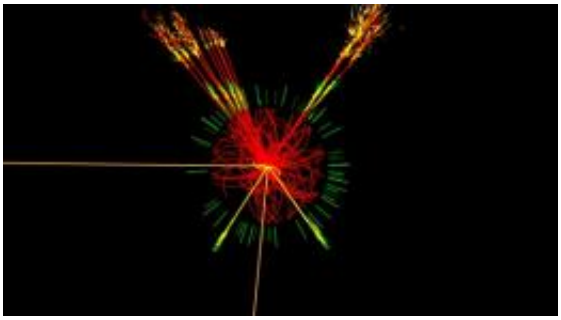
Following Higgs discovery, physicists offer vision to unravel mysteries of universe

August 8 2013



Simulated production of a Higgs event in ATLAS. Image credit: CERN.

After nine days of intensive discussions, nearly 700 particle physicists from about 100 universities and laboratories concluded nine months of work with a unified framework for unmasking the hidden secrets of matter, energy, space and time during the next two decades.

Physicists have made remarkable advances in understanding the fundamental laws of the universe during the last two years. On July 4, 2012, the world celebrated the discovery of the Higgs boson at the Large Hadron Collider in Geneva, Switzerland. The discovery, made possible by more than 1,500 U.S. scientists providing talent, technology and leadership, ended a decades-long search for the elusive particle. Physicists working in other facilities made progress in unmasking some of the bizarre behavior of particles called neutrinos.

But despite these successes, puzzling questions about the nature of the universe remain unanswered. For example, the essential properties of neutrinos are still a mystery. And dark matter and dark energy, which together constitute 95 percent of the universe, are today still astonishing enigmas.

Scientists debated those and other questions July 28-Aug. 6 at the University of Minnesota during the 2013 Snowmass Community Summer Study, the capstone in a series of meetings held last year. They wrapped up their work by identifying the most exciting and vital questions facing particle physics and by providing a 20-year outlook for the investigative work needed to address them. The final report of the Summer Study, to be published this fall, will detail the scientific importance of each question and the scientific instruments required to probe them.

The following provides a flavor of the questions:

- The Higgs particle is unlike any other particle we have ever encountered. Why is it different? Are there more?
- Neutrinos are very light, elusive particles that change their identity as they travel. How do they fit into our understanding of nature?
- Known particles constitute 1/6 of all the matter in the universe. The rest we call dark matter. But what is it? Can we detect these particles in our labs? Are there other undiscovered particles in nature?
- There are four known forces in nature. Are these manifestations of a single unified force? Are there unexpected new forces?
- Are there new hidden dimensions of space and time?
- Both matter and anti-matter were produced in the Big Bang, but today our world is composed only of matter. Why?
- Why is the expansion of the universe accelerating?

"There's a great deal of energy and a host of ideas in the field of particle physics," said Jonathan Rosner, chair of the American Physical Society's Division of Particles and Fields. "In the last 12 months, we've discovered the Higgs boson and made important discoveries about the behavior of neutrinos. It's clear that there is much more to discover. We understand less than 5 percent of the matter and energy in our universe. What experiments can help expand our knowledge in the next 20 years?"

Significantly, the final report of the Summer Study will reflect the ideas of the next generation of scientists who will become the stewards of particle physics. It will include the results of a survey of graduate students, postdoctoral researchers and young staff scientists in the field.

"The Snowmass process is about planning the next generation of experiments, many of which have decade-long lead times," said Jonathan Asaadi, a researcher at Syracuse University. "Decisions made today will shape the careers of the young scientists who will run these experiments many years from now. Our survey of nearly 1,000 young scientists has provided a valuable perspective."

More information: Organized by the American Physical Society, the Snowmass study brought together experts in particle detectors, particle accelerators, theoretical and experimental physics, computing and many other areas of research related to particle physics. Its report will help inform the U.S. Particle Physics Project Prioritization Panel (P5), which will develop a strategic plan and advise the U.S. Department of Energy and the National Science of Foundation on future U.S. particle physics investments.

Provided by American Physical Society