Physicists to mark 20th anniversary of first string theory revolution

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Twenty years have passed since the first superstring revolution started in the Aspen Center for Physics in Colorado. Approximately 75 scientists will meet for a symposium at the center Aug. 12 to celebrate the revolution, including Jeffrey Harvey, the Enrico Fermi Distinguished Service Professor in Physics at the University of Chicago. Harvey will present the symposium's opening address, titled "The impact of the '84 revolution on physics, or how I learned to stop worrying and love superstring theory."

Growing numbers of physicists see superstring theory as their best chance to formulate a set of natural laws that govern everything from the largest galaxies to the smallest quarks in one grand unifying theory of everything. The two men who started the revolution, Michael Green, now of the University of Cambridge, and John Schwarz of the California Institute of Technology, also will speak at the symposium.

String theory had emerged in the late 1960s, only to be plagued by some apparent mathematical inconsistencies. In 1984 Green and Schwarz showed that they could resolve the inconsistencies under certain circumstances. "Before that there were essentially two or three people in the whole world working on string theory," Harvey said. "Within a year there were several hundred. Now there are probably a thousand people at top universities working on this topic."

Soon after Green and Schwarz's discovery, Harvey, in collaboration with Emil Martinec, Professor in Physics at the University of Chicago, and two other colleagues published a paper proposing heterotic string theory, a hybrid that combined two versions of string theory into one. The four scientists were then all working at Princeton University. They were jokingly called the Princeton String Quartet.

"It is now understood that our construction, and Green and Schwarz's string, are all different pieces of a somewhat bigger theory, sometimes called M-theory, that we are still trying to grasp," Martinec said.

A second paper written in the months following Green and Schwarz's discovery showed how string theory meshed with the prevailing body of knowledge describing the interaction of subatomic particles. That paper was written by Philip Candelas, now of Oxford University; Gary Horowitz of the University of California, Santa Barbara; Andrew Strominger of Harvard University; and Ed Witten of the Institute for Advanced Study in Princeton, N.J.

"Those two papers following up Green and Schwarz really cemented this revolution, or made it clear that something big had been discovered," Harvey said.

Martinec recalls the excitement that surrounded Green and Schwarz's discovery. "It was the first time that one had a theory in which gravity was combined with the other fundamental forces, such as electromagnetism, and the other elementary particles, such as electrons and quarks that make up ordinary matter, all together in a single, all-encompassing framework," he said. "It was perhaps the most exciting period that I have experienced in our little corner of science."

Physicists have yet to verify string theory in the laboratory, despite a second superstring revolution that came about in the mid-1990s. Strings measure an estimated millionth of a billionth of a billionth of a billionth of a centimeter across. This is beyond the capability of modern particle accelerators to detect. Yet scientists may see evidence that supports string theory when the Large Hadron Collider (LHC) begins operating at CERN, the European particle physics laboratory, in 2007 or 2008. "But there's no guarantee," Harvey said.

Such evidence might reveal supersymmetry-new particles that would be partners of known elementary particles. "Supersymmetry was partly discovered as an outgrowth of string theory, and it fits naturally into string theory, so I think to many physicists it would be at least an indication that string theory is on the right track," Harvey said.

In his talk, Harvey will address the anxiety that string theory has produced.

"There's a lot of new mathematics that has come out of string theory, new ideas and techniques, and it makes a lot of physicists and a lot of mathematicians very anxious," Harvey said.

Physicists are anxious because string theory has become popular, but it is not yet grounded in experiment. Mathematicians, meanwhile, are nervous because it produces new mathematical ideas that aren't backed up by formal mathematical proofs.

"Part of my theme is going to be that string theory is something that straddles both mathematics and physics, but doesn't quite fit perfectly into either one," Harvey said.

Harvey takes solace from a conversation that he had with Harvard University science historian Peter Galison. The two discussed how fields that cut across disciplinary boundaries tend to make the specialists in those disciplines nervous because "it questions the assumptions that they work under," Harvey said. But Galison noted that in the history of science, the fields that make scientists nervous also become the most fruitful. String theory seems to fit into that category.

"It's an intellectual enterprise that's extremely exciting and vigorous and full of ideas," Harvey said.

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