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Physicists' Dreams and Worries in Era of the Big Collider

By DENNIS OVERBYE

A few dozen scientists got together in Los Angeles for the weekend recently to talk about their craziest hopes and dreams for the universe. At least that was the idea.

"I want to set out the questions for the next nine decades," Maria Spiropulu said on the eve of the conference, called the Physics of the Universe Summit. She was hoping that the meeting, organized with the help of Joseph D. Lykken of the Fermi National Accelerator Laboratory and Gordon Kane of the University of Michigan, would replicate the success of a speech by the mathematician David Hilbert, who in 1900 laid out an agenda of 23 math questions to be solved in the 20th century.

Dr. Spiropulu is a professor at the California Institute of Technology and a senior scientist at CERN, outside Geneva. Next month, CERN's Large Hadron Collider, the most powerful particle accelerator ever built, will begin colliding protons and generating sparks of primordial fire in an effort to recreate conditions that ruled the universe in the first trillionth of a second of time. Physicists have been speculating for 30 years what they will see. Now it is almost Christmas morning.

Organized into "duels" of world views, round tables and "diatribes and polemics," the conference was billed as a place where the physicists could let down their hair about what might come, avoid "groupthink" and "be daring (even at the expense of being wrong)," according to Dr. Spiropulu's e-mailed instructions. "Tell us what is bugging you and what is inspiring you," she added.

Adding to the air of looseness, the participants were housed in a Hollywood hotel known long ago as the "Riot Hyatt," for the antics of rock stars who stayed there. The eclectic cast included Larry Page, a co-founder of Google, who was handing out new Google phones to his friends; Elon Musk, the PayPal electric-car entrepreneur, who hosted the first day of the meeting at his SpaceX factory, where he is building rockets to ferry supplies and, perhaps, astronauts to the space station; and the filmmaker Jesse Dylan, who showed a new film about the collider. One afternoon, the magician David Blaine was sitting around the SpaceX cafeteria doing card tricks for the physicists.

This group proved to be at least as good at worrying as dreaming.

“We’re confused,” Dr. Lykken explained, “and we’re probably going to be confused for a long time.”

The first speaker of the day was Lisa Randall, a Harvard theorist who began her talk by quoting Galileo to the effect that physics progressed more by working on small problems than by talking about grand ones — an issue that she is taking on in a new book about science and the collider. And so Dr. Randall emphasized the challenges ahead. Physicists have high expectations and elegant theories about what they will find, she said, but once they start looking in detail at these theories, “they’re not that pretty.”

For example, a major hope is some explanation for why gravity is so weak compared with the other forces of nature. How is it that a refrigerator magnet can hold itself up against the pull of the entire Earth? One popular solution is a hypothesized feature of nature known as supersymmetry, which would cause certain mathematical discrepancies in the calculations to cancel out, as well as produce a plethora of previously undiscovered particles — known collectively as wimps, for weakly interacting massive particles — and presumably a passel of Nobel prizes.

In what physicists call the “wimp miracle,” supersymmetry could also explain the mysterious dark matter that astronomers say makes up 25 percent of the universe. But no single supersymmetrical particle quite fits the bill all by itself, Dr. Randall reported, without some additional fiddling with its parameters.

Moreover, she added, it is worrying that supersymmetric effects have not already shown up as small deviations from the predictions of present-day physics, known as the Standard Model. “A lot of stuff doesn’t happen,” Dr. Randall said. “We would have expected to see clues by now, but we haven’t.”

These are exciting times, she concluded, but the answers physicists seek might not come quickly or easily. They should prepare for surprises and trouble.
“I can’t help it,” Dr. Randall said. “I’m a worrier.”

Dr. Randall was followed by Dr. Kane, a self-proclaimed optimist who did try to provoke by claiming that physics was on the verge of seeing “the bottom of the iceberg.” The collider would soon discover supersymmetry, he said, allowing physicists to zero in on an explanation of almost everything about the physical world, or at least particle physics.
But he and other speakers were scolded for not being bold enough in the subsequent round-table discussion.

Where, asked Michael Turner of the University of Chicago, were the big ideas? The passion? Where, for that matter, was the universe? Dr. Kane’s hypothesized breakthrough did not include an explanation for the so-called dark energy that seems to be speeding up the expansion of the universe.

Dr. Kane grumbled that the proposed solutions to dark energy did not affect particle physics. The worrying continued. Lawrence Krauss, a cosmologist from Arizona State, said that most theories were wrong.

"We get the notions they are right because we keep talking about them," he said. Not only are most theories wrong, he said, but most data are also wrong — at first — subject to glaring uncertainties. The recent history of physics, he said, is full of promising discoveries that disappeared because they could not be repeated. And so it went.

Maurizio Pierini, a young CERN physicist, pointed out that the tests for new physics were mostly designed to discover supersymmetry. "What if it's not supersymmetry?" he asked.
Another assumption physicists have taken for granted — that dark matter is a simple particle rather than an entire spectrum of dark behaviors — might not be true, they were told. "Does nature really love simplicity?" Aaron Pierce of the University of Michigan asked.

Neal Weiner of New York University, who has suggested the existence of forces as well as particles on the dark side, said that until recently ideas about dark matter were driven by ideas about particle theory rather than data.

"Ultimately we learn that perhaps it has very little to do with us at all," Dr. Weiner said. "Who knows what we will find in the dark sector?"

At one point, Mark Wise, a theoretical physicist at Caltech, felt compelled to remind the audience that this was not a depressing time for physics, listing the collider and other new experiments on heaven and on earth. "You cannot call this a depressing time," he said.
Dr. Randall immediately chimed in. "I agree it's a good time," she said. "We'll make progress by thinking about these little problems."

On the second day, the discussion continued in an auditorium at Caltech and concluded with a showing of Mr. Dylan's film and a history talk by Lyn Evans, the CERN scientist who has supervised the building of the Large Hadron Collider through its ups and downs over 15 years, including a disastrous explosion after it first started up in 2008.

Dr. Evans, looking relaxed, said: "It's a beautiful machine. Now let the adventure of discovery begin." Dr. Spiropulu said it had already begun. Her detector, she said, recorded 50,000 proton collisions during the testing of the collider in December, recapitulating much of 20th-century particle physics.

Now it is the 21st century, Dr. Spiropulu said, and "all that has been discussed these last few days will be needed immediately."
Correction: January 25, 2010
An earlier version of this article misstated the affiliation of Aaron Pierce, a physicist. He is with the University of Michigan, not the California Institute of Technology.