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SCIENTIST AT WORK -- Maria Spiropulu; Other Dimensions? She's in Pursuit

By DENNIS OVERBYE

Flap harder, urged the little girl with the stopwatch.

One by one, the children stepped up and launched themselves off the garden wall, flapping homemade wings with their arms. Always with the same result.

Crash.

Only the girl herself, 7 years old, an aspiring dancer, astronaut, wing maker and free spirit, could not jump -- not out of fear or lack of confidence in the wings she had made, but because she could not time her own flight. "And I didn't trust anybody to time it for me," she recalled. She already had the soul of a scientist, as well as a knack for leadership.

Crash.

Just before midnight on a recent summer night, the girl, Dr. Maria Spiropulu, now 33 and a physicist affiliated with the University of California at Santa Barbara, stepped outside a South Side Chicago jazz club and climbed into a cluttered Honda Civic. She was wearing black jeans, a black sleeveless top, Nikes and three rings on her left hand. Spewing noise from a leaky muffler, she drove into the Illinois prairie, through the gates of the Fermi National Accelerator Laboratory, or Fermilab, and past scattered farmhouses too white and neat to be real farmhouses anymore.

Mars' bloody stare was high in a hazy sky by the time she parked outside a hulking shedlike building. Inside the shed, the ground floor rimmed a huge pit three stories deep and wide as a basketball court, littered with the toys of industrial strength science -- cranes, racks of electronics, tool chests, cables, long magnets stacked like redwood logs.

Behind a wall at one end of the pit, smack in the beam of Fermilab's Tevatron, the world's biggest particle accelerator, sat a three-story 5,000-ton assembly of magnets, crystals, electronics, wires and computers known as the Collider Detector Facility.

The C.D.F., as it is called, was perhaps the most exquisite and expensive stopwatch ever built. Dr. Spiropulu was hoping to use it to time not the flight of flapping little cousins, but the flight of particles going right out of this world altogether, disappearing into another dimension, like a billiard ball popping straight up off the table or the phantom voices conjured by 19th-century mediums.

The discovery would confirm some of the boldest and most far-reaching theories in physics, which imply that nature has 10 or 11 dimensions, not the 3 of space and 1 of time that frame our normal experience.

In a control room upstairs, the air was humming with imagined energy of a trillion volts; 50 computer screens were lit up, and one laptop lay open on a desk.

The screens showed the progress three stories below where 36 batches of protons were whirling around a 4-mile racetrack 40,000 times a second. Now, as a disembodied computerized female voice ticked off every step of the process, antiprotons, the antimatter mirror antagonists of protons, were being inserted, batch by batch, into the same racetrack but in opposite directions.

If all went well, protons and antiprotons would soon be colliding millions of times a second, replicating a little bit of the universe circa a trillionth of a second after the Big Bang, annihilating one another in a fireball of energy and spraying bits of matter and energy through the C.D.F. and perhaps out of the world as we know it.

But there was nothing mystical about Dr. Spiropulu's mood. As the minutes ticked down she was in nerd mode, hunched over a computer terminal like a kid doing last-minute homework. She was running a test to diagnose the health of the detector, inserting false data into one end of the labyrinth of wires, detectors, filters and programs that must decide in a fleeting instant which few dozen of the three million big bangs per second were interesting enough to record and study, and then checking to see that it emerged unscathed out the other end.

"It is like a physical checkup," she explained, admitting that it was "extremely tedious." But it is with exacting solicitude for the subtleties of measurement that Dr. Spiropulu, a self-described "lab chick," has made her mark in the physics world, combining a hard scientific conservatism and personal exuberance that has prompted her to deliver karate kicks in a physics talk

"Physics is not my job; it is my life," she says. "The world is what you measure."

"Everybody is entitled to their own opinion," she likes to say, "but they're not entitled to their own facts. The data is the data."

So far, the fifth dimension has not been found. Nor has the sixth, seventh, eighth, ninth or tenth.

On Sept. 19, after a year of preparation, Dr. Spiropulu, Dr. Kevin Burkett of Harvard and half a thousand co-authors reported that any spatial extra dimensions, if they exist, must be curled up into circles smaller than a hundredth of an inch to a trillionth of an inch or so across, depending on how many there are and how they are configured.

The results complement those of a sister Fermilab team led by Dr. Greg Landsberg of Brown and Dr. Ryan Hooper of Notre Dame, who used another giant detector, known as D0, and different methods.

Dr. Spiropulu vows that the search has only begun. If they don't find extra dimensions, physics will find something just as "crazy," either at Fermilab or at CERN's Large Hadron Collider, which will turn on with seven times as much energy in 2007, and may produce miniature black holes, if the theory is right.

Dr. Spiropulu said she would move back to Geneva and CERN early next year, where her career began, to help prepare for a revolution she says "will blow our minds."

Born in Greece, the daughter of a businessman and a teacher of fashion design, Dr. Spiropulu describes herself as a demanding child. "I wasn't crazy, but annoying," she said, asking too many questions. That impression, she said, lingers today.

As a young girl she dreamed of being an astronaut, but the Greek air force academy did not accept women, so she went to Aristotle University of Thessaloniki and majored in physics. "I knew my life was as an experimental physicist," she said.

After graduation, she borrowed $500 from her father and went to CERN, where she got a job as a technical assistant. From there, she went to Harvard for her Ph.D. in particle physics. Most of those years were spent at Fermilab, serving a gritty apprenticeship on and in the giant C.D.F.

She played drums and sang for a Fermilab band called Drug Sniffing Dogs until she was expelled for not attending rehearsals.

There was a dark period, she acknowledges, in 1996, when two close friends, both Greek scientists, died -- one in a car accident, the other on Swissair Flight 111 that crashed off Nova Scotia.

She said the memory of those days still hurt. "I can fight and fight," she said, "but there are a bunch of things that nothing can turn them around. Death is one."

For her doctoral thesis, she developed a kind of blind analysis similar to that used in drug trials to search the accelerator's output for evidence of a desperately sought phenomenon known as supersymmetry.

If supersymmetry, generally regarded as the next great thing in particle physics, is true, there is a whole set of ghostlike elementary particles yet to be discovered. But how to sort their signatures from known phenomena that can mimic them?

Dr. Spiropulu's strategy was to set aside "in a box" the data that might show the new particles. Then she analyzed the rest of the data, which presumably did not contain any "new physics," and used the results to predict how many "background events" should show up when the box was finally "opened."

Knowledge of this background is crucial if you don't want your big discovery to turn out to be a mirage.

When she opened the box three years ago in front of her C.D.F. colleagues, her calculations turned out to be dead on. That meant no supersymmetry. Yet.

"Everybody else was clapping, and I was about to cry," she said then. But at least with no arresting claim to defend, she could focus on her dissertation.

After graduation Dr. Spiropulu joined the University of Chicago and applied her expertise to the search for extra dimensions.

It might seem obvious that we live in a world of three spatial dimensions and one of time. But physicists have become enamored of string theory, the "theory of everything," which posits that nature is ultimately composed of tiny vibrating strings. And the theory only makes mathematical sense if space-time actually has 10 dimensions.

To explain the discrepancy between theory and experience, string theorists have posited that the extra dimensions are rolled up, like the pile on a carpet, into little circles or six-dimensional balls, less than a trillionth the size of an elementary particle.

In 1998, however, three theorists -- Dr. Nima Arkani-Hamed of Harvard, Dr. Savas Dimopoulos of Stanford and Dr. Gia Dvali of

New York University -- suggested that if some of these extra dimensions were larger, as much as a millimeter, it could explain one of the enduring mysteries of physics. Why is gravity is so weak compared with the other fundamental forces of nature?

That this is so can be seen by the fact that a plywood board, held together by electromagnetic forces between atoms, is enough to counter the gravitational pull of the entire Earth on a human body: we don't regularly fall through the floor.

Supersymmetry is one way to shore up this mathematical gap, but large extra dimensions, they said, might be another.

Suppose, they said, that gravity is actually comparable to the other forces in strength and only appears weaker because it is diluted by propagating through the extra dimensions, while the other forces are confined to the ordinary three dimensions.

In the so-called A.D.D. version, after the authors above, the extra dimensions are little circles. But in another version, developed by Dr. Lisa Randall of Harvard and Dr. Raman Sundrum at Johns Hopkins, one of the extra dimensions can be infinite.

If any of these ideas are right, it means that even with Fermilab's Tevatron, physicists may be nibbling at the energies that produce black holes or strings.

In ordinary physics, such effects occur only at the so-called Planck energy, 1019 billion electron volts, at which space-time itself appears bumpy and the paradoxical rules of quantum mechanics have to be applied to gravity. Physicists would need an accelerator the size of a galaxy -- and a budget to match -- to get there.

Dr. Spiropulu and Dr. Burkett have focused on one possibility, namely that the collision of a proton and an antiproton -- or of the quarks and gluons inside of them -- will produce a graviton, the hypothesized particle of force that carries gravity.

In ordinary physics, all gravitons would be massless like the photon that carries light. But a graviton's motion in the extra dimensions would look like extra mass or energy, Dr. Spiropulu said.

And that mass would be conspicuous by its disappearance. "Once I make my 6-D graviton, it heads off into the extra dimensions," she explained. In the detector's strict bookkeeping, it would look as if energy were disappearing from a collision.

So far the missing gravitons are, well, still missing. But, Dr. Spiropulu says, "It's interesting that we can have limits already, and not just sit and wring our hands."

Her analysis was based on Tevatron data obtained from 1992 to 1996. The machine has since been upgraded to produce slightly more energetic, brighter beams.

There are still four more years for her or the D0 team to grab the brass ring before CERN's new collider takes over.

One afternoon in August, as the beams hummed and banged downstairs, some events interesting to have survived winnowing by Dr. Spiropulu's "trigger" programs were being flashed, one after another, on a pair of computer screens in the control room. They appeared as spiky tracks or as bumps of energy going in different directions.

To a particle physicist, these were familiar old friends. Here, Dr. Spiropulu said, was probably a J/Psi particle, whose discovery in 1974 had led to a Nobel Prize. Another was probably a W particle, the carrier of the so-called weak force, whose discovery in 1983 also brought a Nobel.

Was there another discovery flashing as yet unrecognized on the screens?

"We do have things that give us the right to think we are seeing a little hint of new physics," she said.

"It's an educated hope. It's not wishful thinking."