Focus | IN DEPTH

Lots in space

UCI scientists use first neutrino telescope to try to unlock secrets that baffled even Einstein.

Story by PAT BRENNAN
Graphic by SCOTT BROWN
THE ORANGE COUNTY REGISTER

Tiny black holes whizzing through Earth's atmosphere several times a minute. Gravity "leaking" into other dimensions. A solution to a mystery that vexed Einstein to his grave.

It sounds a lot like science fiction, but it isn't. Each of these fantastic possibilities – and a good many more – could be made real with the help of a giant instrument in the Antarctic ice that one astrophysicist compared to Galileo's first telescope.

AMANDA, a hunter of ghostly particles known as neutrinos, is ready to go to work. Scientists are now fine-tuning the instrument.

"We are going to look for the most powerful and exotic objects out there," said astrophysicist Steven Barwick of the University of California, Irvine, now at the South Pole, where the temperature was -4 degrees Fahrenheit.

What excites Barwick and other scientists is AMANDA's revolutionary potential. It is a telescope, but a radically different kind: one that, for the first time in history, will not rely on light to gather information about exotic objects in the distant universe.

Steven Barwick

Instead, it will rely on neutrinos, particles with no charge and almost no mass that barely interact with matter at all. The detector, a massive array of light-sensitive globes buried in the clear Antarctic ice, has had its first test run, UCI and National Science Foundation officials will announce today.

It will now begin scanning the heavens for some of the strangest objects known to astronomy – and try to confirm some of the weirdest ideas in modern physics.

Seeing the universe with neutrinos could revolutionize both fields. Neutrinos are everywhere; billions are zipping through your body every second. But in a sense, they seem hardly here at all. A neutrino could plow through 10,000 Earths without bumping into anything, or even slowing down.

That makes them extremely hard to detect – part of the reason AMANDA, though sunk entirely beneath the surface of the polar ice, is longer than the Eiffel Tower is tall.

The same thing that makes neutrinos hard to find also makes them ideal for peering into the cosmos. Light from distant objects can be blocked, scattered or distorted by the dust and gas it must pass through to reach Earth. Neutrinos streaming from the same objects, however, arrive in pure form.

For scientists, it will be like switching from grainy black-and-white television with rabbit-ear antennas to a crisp Sony Trinitron on cable. They could watch the births or the death throes of stars as if they were happening next door.

But what has captivated theorists like Jonathan Feng, also at UCI, is the chance that AMANDA could at last reveal whether cutting-edge ideas in physics – the possible existence of multiple dimensions or even microscopic black holes that blink in and out of existence in a tiny fraction of a second – are grounded in reality.

"Physicists and theorists like me can postulate whatever we feel like," Feng said. "But the proof is in the pudding."

Feng's theories would make Rod Serling proud. And if shown to be correct, they could shed light on a puzzle that troubled Einstein.

Since Albert Einstein's day, scientists who study the origin of the universe and everything in it have had a big problem. Three of the four forces holding matter and our universe together, the strong and weak nuclear forces and the electromagnetic force, have been joined happily under a single theory, one that describes precisely how all three work.

The troubled stepchild is gravity. Though it causes stars and planets to form and holds galaxies in thrall, gravity is extremely weak on the tiniest scales. The repulsive force between electrons, for instance, is a trillion trillion trillion times more powerful than gravity.

But why? That's what bothered Einstein. He spent his last years fruitlessly trying to unite gravity with the other forces.

No one else has been able to, either. But Feng has a fascinating way out. What if, he wonders, gravity operates in more dimensions than the other forces? That would mean instead of our familiar four dimensions – three of space, one of time – the universe might contain as many as 10 or 11, as some theories suggest.

Those theories say these extra dimensions would be so tiny and tightly curled that nothing we have could ever detect them. But it's also possible they aren't quite so small, Feng says. It's possible they're connected in some way to the measurable universe.

If so, one fascinating possibility is a continual rain of microscopic black holes in our atmosphere.

Most astronomers and physicists agree that massive black holes, stars that have collapsed under such a heavy load of gravity that they suck in everything, including light, are found throughout the universe – even at the center of our galaxy.

But it's just possible, Feng said, that microscopic, fleeting black holes may exist as well. He says careful calculations show that these could only exist in a universe with extra dimensions.

High-energy neutrinos like those detected by AMANDA could be creating such black holes when they strike atmospheric particles on Earth.

They would wink out again in almost no time, but not before causing a kind of microscopic traffic accident, with bits and pieces flying everywhere.

By detecting those bits and pieces, AMANDA could prove such black holes exist. And if they do, it would be solid proof of the existence of other dimensions. That would mean that gravity is actually a strong force, as strong as the others, but a shadow of itself when measured only in our familiar set of four dimensions.

Jonathan Feng

"It might look very calm and weak," Feng said. "But that is just because it's being spread over a huge amount of different dimensions."

Such a discovery would be a key to linking gravity with the other forces and solving the greatest riddle in the universe.

It could open the door to explaining what happened before the big bang, what "dark matter" – which dominates the universe but has never been detected – is made of, and where things go when they disappear into the maw of a black hole.

"We have a long way to go," Feng said. "But it will be exciting to see how it all turns out."

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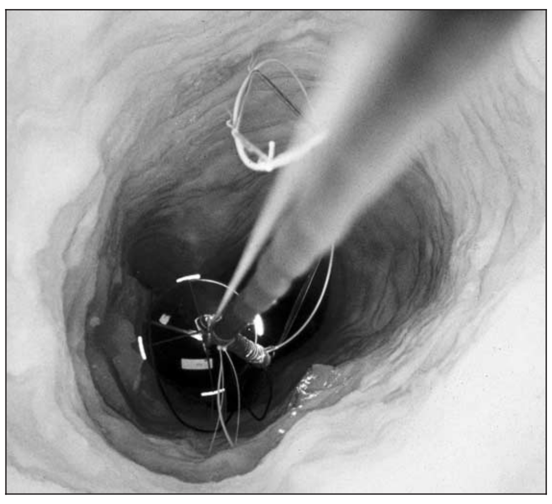
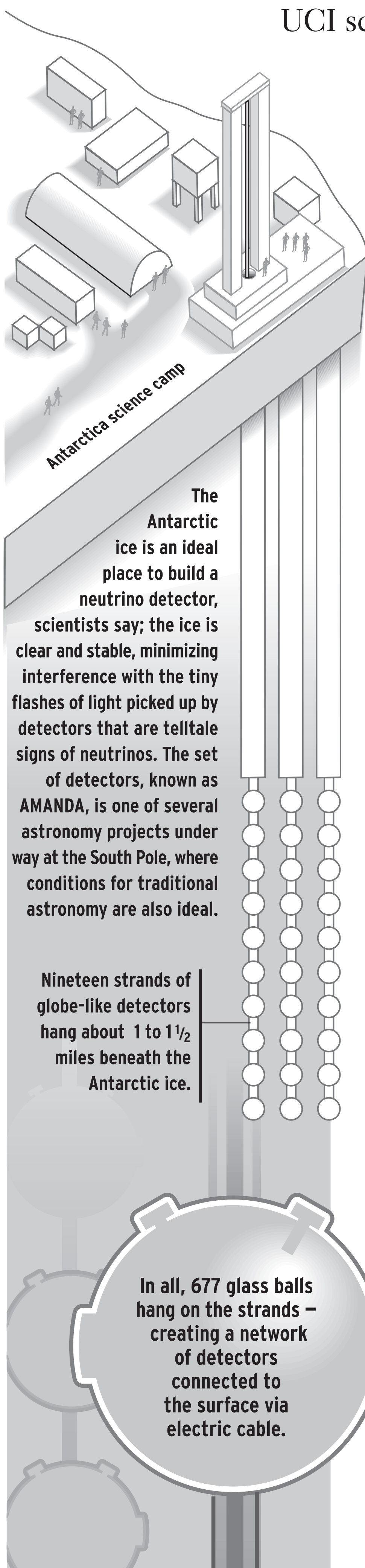
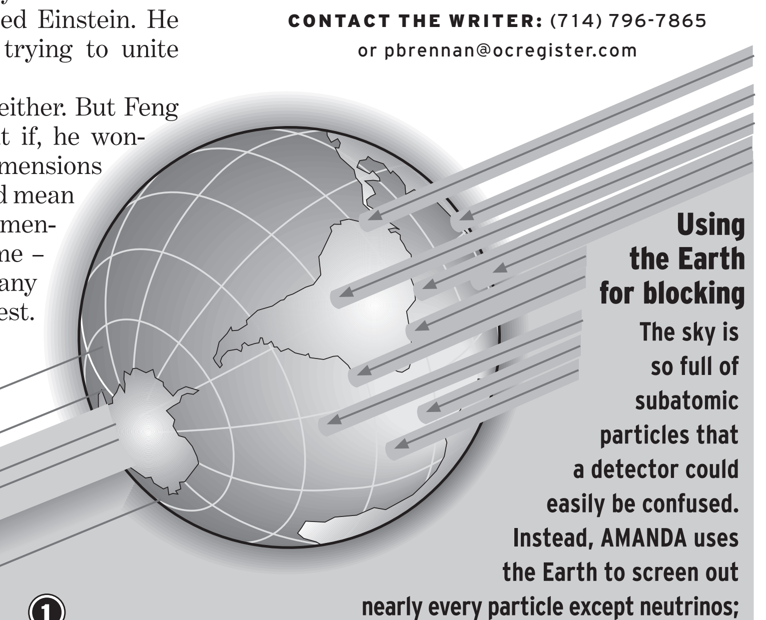
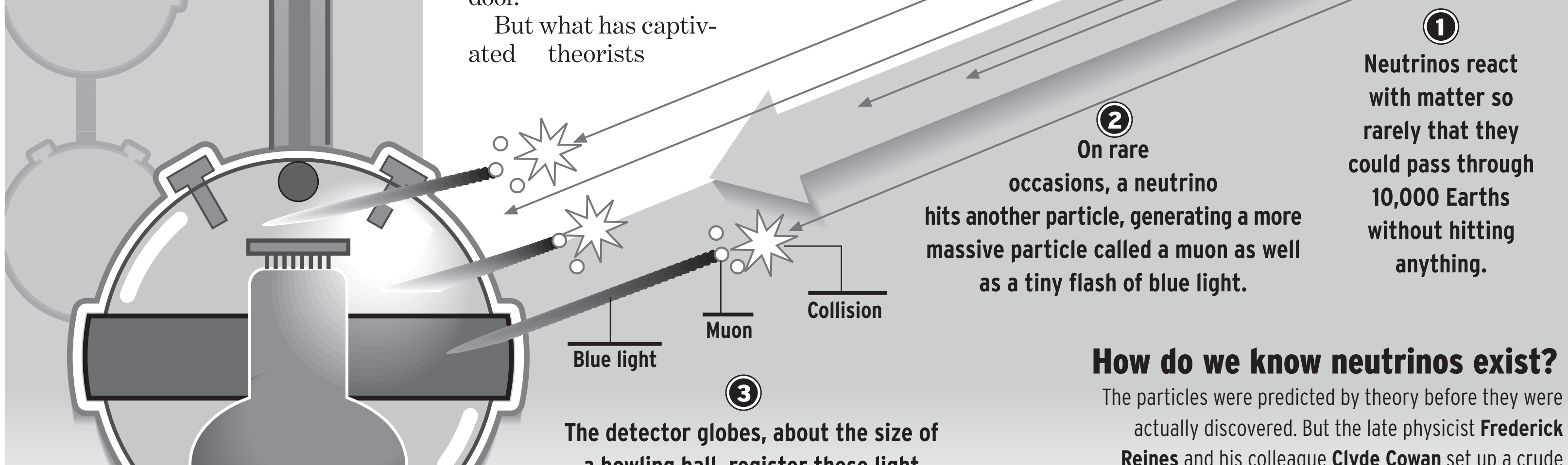


ROBERT MORSE, UNIVERSITY OF WISCONSIN, MADISON

BENEATH THE POLAR ICE: Neutrino detectors are lowered as far as 1,500 meters down a well drilled through the Antarctic icecap.







How do we know neutrinos exist?

The particles were predicted by theory before they were actually discovered. But the late physicist **Frederick Reines** and his colleague **Clyde Cowan** set up a crude detector outside a nuclear reactor in South Carolina in 1956 to try to capture the elusive particle. Other scientists said their attempt would fail, but they detected neutrinos. Reines won a Nobel Prize for his discovery in 1995, when he was a researcher at the University of California, Irvine.

File photo: UC Irvine

This 1953 photo shows Fred Reines, right, and Clyde Cowan in the control center of the Hanford Experiment beginning the first experiments to establish the existence of neutrinos.

Reporting by Pat Brennan / The Register Sources: University of Wisconsin; University of California, Irvine