

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

**T**iny 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.

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.

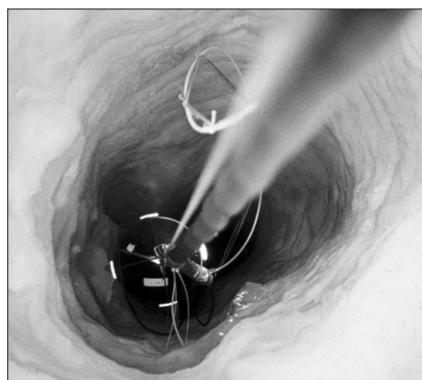
Seeing the universe with neutrinos could revolutionize both fields. Neutrinos are everywhere; billions are zipping through your body every second. But in a sense, they seem hardly here at all. A neutrino could plow through 10,000 Earths without bumping into anything, or even slowing down.

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



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.

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.

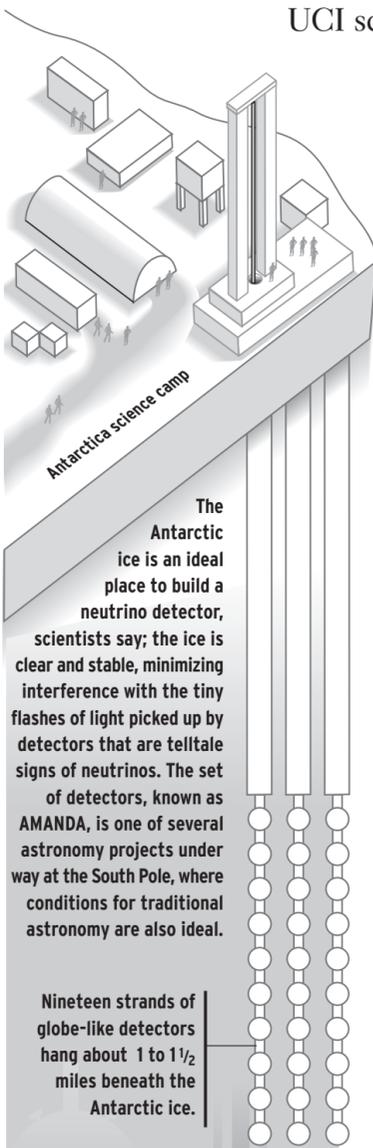
"It might look very calm and weak," Feng said. "But that is just because it's being spread over a huge amount of different dimensions."

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."

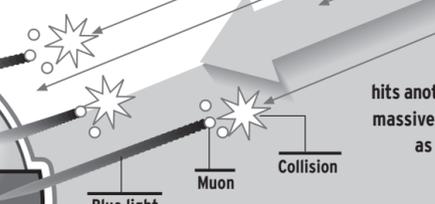
CONTACT THE WRITER: (714) 796-7865  
or pbrennan@ocregister.com



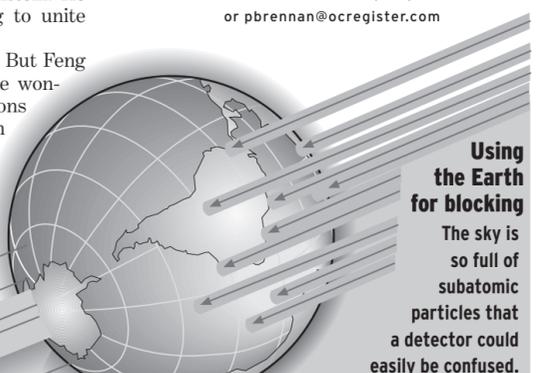
The Antarctic ice is an ideal place to build a neutrino detector, scientists say; the ice is clear and stable, minimizing interference with the tiny flashes of light picked up by detectors that are telltale signs of neutrinos. The set of detectors, known as AMANDA, is one of several astronomy projects under way at the South Pole, where conditions for traditional astronomy are also ideal.

Nineteen strands of globe-like detectors hang about 1 to 1½ miles beneath the Antarctic ice.

In all, 677 glass balls hang on the strands – creating a network of detectors connected to the surface via electric cable.



The detector globes, about the size of a bowling ball, register these light flashes and transmit the data up the long cables to the recording equipment at the surface.

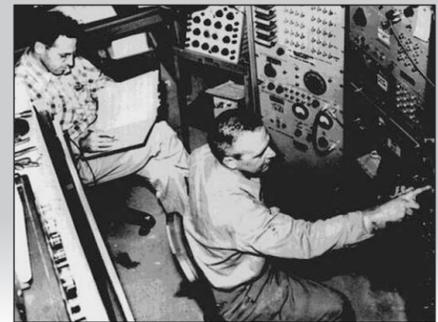


Using the Earth for blocking

The sky is so full of subatomic particles that a detector could easily be confused.

Instead, AMANDA uses the Earth to screen out

nearly every particle except neutrinos; if the detectors register evidence of a particle zipping through the planet, they know it's a neutrino.



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.

① Neutrinos react with matter so rarely that they could pass through 10,000 Earths without hitting anything.

② On rare occasions, a neutrino hits another particle, generating a more massive particle called a muon as well as a tiny flash of blue light.

**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.

Note: Objects shown are not actual size

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

MOTOROLA C331g

# 5600 MINUTES \$39.99 MO.

600 Rollover Anytime Minutes and 5000 Night and Weekend Minutes. (Rollover does not apply to night & weekend minutes.)

Mon-Fri 10-8  
Sat 10-7 • Sun 12-7

**FamilyTalk<sup>SM</sup>**

Share Your Minutes with up to 3 family members. Just \$19.99 per month per line!

- **FREE UNLIMITED Mobile to-Mobile\***
- Get up to 4 FREE Phones\* (with 2-year Agreement after \$50 mail-in rebate.)
- FREE activation (\$36 value) when you purchase a Spiderman DVD!\*

**LAST 5 DAYS!**

## \$50 CREDIT

Out with the old. In with the new.

When you trade in a non-Cingular wireless phone, battery and charger\* & activate on a new 2 year Cingular plan.

You deserve some credit for that old phone.

Authorized Agent of

**NOKIA**  
Nokia 6590i  
**\$49.99\***

with 2-year Agreement after \$50 mail-in rebate & \$50 trade-in credit

**MOTOROLA**  
Motorola V60gi  
**\$49.99\***

with 2-year Agreement after \$50 mail-in rebate & \$50 trade-in credit

**MOTOROLA**  
Motorola T720 with Color Screen  
**\$149.99\***

with 2-year Agreement after \$50 mail-in rebate & \$50 trade-in credit

**FREE\*** with 2-year Agreement after \$50 mail-in rebate

\*Sales tax applies to the full retail value of the phone in CA/NV. Phone offer requires activation on 2-year service agreement. Limited Time Offer Subject To a \$36 activation fee, credit approval, and new activation on eligible Cingular calling plan; offer cannot be combined with other special offers. Offer expires 1/31/03. \*Phone Return Policy/Early Termination Fee No early termination fee if service cancelled within 15 days of purchase; a \$150 early termination fee applies thereafter. Promotional features may be cancelled at end of service agreement. Service Coverage Cingular does not guarantee uninterrupted service coverage at all times in all places; coverage available only on GSM networks in the U.S. Visit www.cingular.com for GSM network coverage maps. Billing/Additional Taxes & Charges Airtime is rounded up to the next full minute for billing purposes. Unused minutes are not carried forward to the next billing period. Airtime exceeding package minutes and other usage is billed at 19¢ per minute. All calls are subject to taxes, universal service charge, gross receipts surcharge and other charges. Package Minutes/Bonus Night & Weekends Package minutes apply to all calls; 5000 Night and Weekend minutes available only on Cingular Preferred Nation plans and Cingular SuperHome plans \$39.99 and higher. Nights are 9 pm to 7 am. Weekends are Friday 9 pm to Monday 7 am. Rollover Minutes: Rollover minutes apply to Cingular Home Plans \$39.99 and higher. Minutes roll over for up to 12 months. Night & Weekend Minutes will not roll over. Rollover only applies to the included minutes. Rollover minutes are not redeemable for cash or credit and are not transferable. Minutes will not roll over until after the first month's billing. Unused minutes do not roll over to the next billing period and are forfeited on non-qualifying plans. Mobile to Mobile (MTM) applies to calls between Cingular customers made while within the Cingular CA/NV/WA/ID GSM network. Long Distance & Roaming No long distance charges on calls starting and ending within the 50 United States. No roaming charges on Cingular Preferred Nation Plans except for calls that require a credit card or maritime calling. Roaming charge for Home plans is 79 cents per minute. Airtime charges still apply to calls made while roaming. FamilyTalk requires a one- or two-year service agreement for each line. \$18 activation fee per line added. FamilyTalk plans include only package and/or rollover minutes included with the primary number and are shared by the additional lines. The rate for additional minutes applies to all minutes in excess of the included minutes. If the rate plan for the primary number is changed to an ineligible plan or the primary number is disconnected, one of the existing additional lines shall become the primary number on the rate plan previously subscribed to by the former primary number. Additional Conditions and Restrictions Apply See contract and store for details. Cingular Wireless, "What do you have to say?" and the graphic icon are Service Marks of Cingular Wireless LLC. ©2002 Cingular Wireless. \*\*Trade-in offer expires 1/31/03. Trade-in requires new service subscription in Cingular's CA/NV/WA/ID markets, under a 2-year agreement on any cingular rate plan. Customer must mail in an analog or digital handset, from a competitor service provider, along with battery and charger, all in working condition. Cingular is not responsible for loss of damaged equipment shipped. Mail-in form provided at participating store locations; must be postmarked no later than 1/31/03 and within 30 days of activation date. Customer is responsible for postage. \$50 credit applied to customer's bill within 60 days following Cingular's receipt of equipment and validation of eligibility. Cingular Wireless, "What do you have to say?" and the graphic icon are Service Marks of Cingular Wireless LLC. ©2002 Cingular Wireless.

**CERRITOS**  
12845 Town Center Dr  
(562) 403-1584

**COSTA MESA**  
1835 Newport Blvd  
(949) 650-1100

**LAGUNA HILLS**  
24321 Ave De La Carlota  
(949) 581-1600

**LOS ALAMITOS**  
10708 Los Alamitos  
(562) 795-7714

**ORANGE**  
4501 E. Chapman  
(714) 538-3600

**PLACENTIA**  
720 North Rose  
(714) 223-0400

**SAN JUAN CAPISTRANO**  
32341 Camino Capistrano  
(949) 488-3590