



HOLEY NOMAD

## Intergalactic hiker

**T**HE most massive black hole ever measured may be an intergalactic hitchhiker that escaped from one galaxy before getting captured by another. If this scenario, laid out in a paper posted February 18 at arXiv.org, is proven correct, it would be the first time astronomers have definitively spotted a black hole that was expelled from its original galactic home.



The boundary of the supermassive black hole in the galaxy NGC 1277.

Computer simulations of galaxy mergers suggest that some supermassive black holes can be nomads: When the galaxies' central black holes unite, they can emit an enormous surge of energy in one direction. That burst would rocket the newly formed black hole in the opposite direction, the simulations say, often with enough speed to escape the galaxy.

Astronomers have scoured telescope images for signs of runaway black holes but have come up with only a few controversial possibilities. "We looked at a lot of objects and didn't find anything," says Erin Bonning, an astronomer at Quest University Canada in Squamish, British Columbia.

But last November, a study in Nature described a gargantuan black hole, 17 billion times the mass of the sun, at the center of a seemingly run-of-the-mill galaxy called NGC 1277 in the Perseus cluster 250 million light-years away. While most galaxies' central black holes make up about one-tenth of a percent of their total mass, NGC 1277's black hole accounts for 14 percent of the galactic mass. "That paper blew everyone's mind," Bonning says. "It's an extraordinary black hole in an ordinary galaxy."

NGC 1277 and its black hole seemed such an odd couple that Bonning and her colleague Gregory Shields, of the University of Texas at Austin, began to question whether the two had evolved together. They studied images of the Perseus cluster and calculated the gravitational interactions of astronomical objects, trying to determine whether this black hole could have been tossed from another galaxy and then snapped up by NGC 1277.

Source: Science News



NO PERMA(FROST) FROST

## Siberia thawing!

**E**VIDENCE from Siberian caves suggests that a global temperature rise of 1.5 degrees Celsius could see permanently frozen ground thaw over a large area of Siberia, threatening release of carbon from soils, and damage to natural and human environments.

A thaw in Siberia's permafrost (ground frozen throughout the year) could release over 1000 gigatonnes of the greenhouse gases carbon dioxide and methane into the atmosphere, potentially enhancing global warming.

The data comes from an international team led by Oxford University scientists studying stalactites and stalagmites from caves located along the 'permafrost frontier', where ground begins to be permanently frozen in a layer tens to hundreds of metres thick. Because stalactites and stalagmites only grow when liquid rainwater and snow melt drips into the caves, these formations record 500,000 years of changing permafrost conditions, including warmer periods similar to the climate of today.

Records from a particularly warm period (Marine Isotopic Stage 11) that occurred around 400,000 years ago suggest that global warming of 1.5°C compared to the present is enough to cause substantial thawing of permafrost far north from its present-day southern limit.

A report of the research is published in this week's Science Express. The team included scientists from Britain, Russia, Mongolia and Switzerland.

"The stalactites and stalagmites from these caves are a way of looking back in time to see how warm periods similar to our modern climate affect how far permafrost extends across Siberia," said Dr Anton Vaks of Oxford University's Department of Earth Sciences, who led the work.

Source: Science Daily



Icy grotto in Baikal, Olkhon Island, Siberia.

# Fifth force of nature?

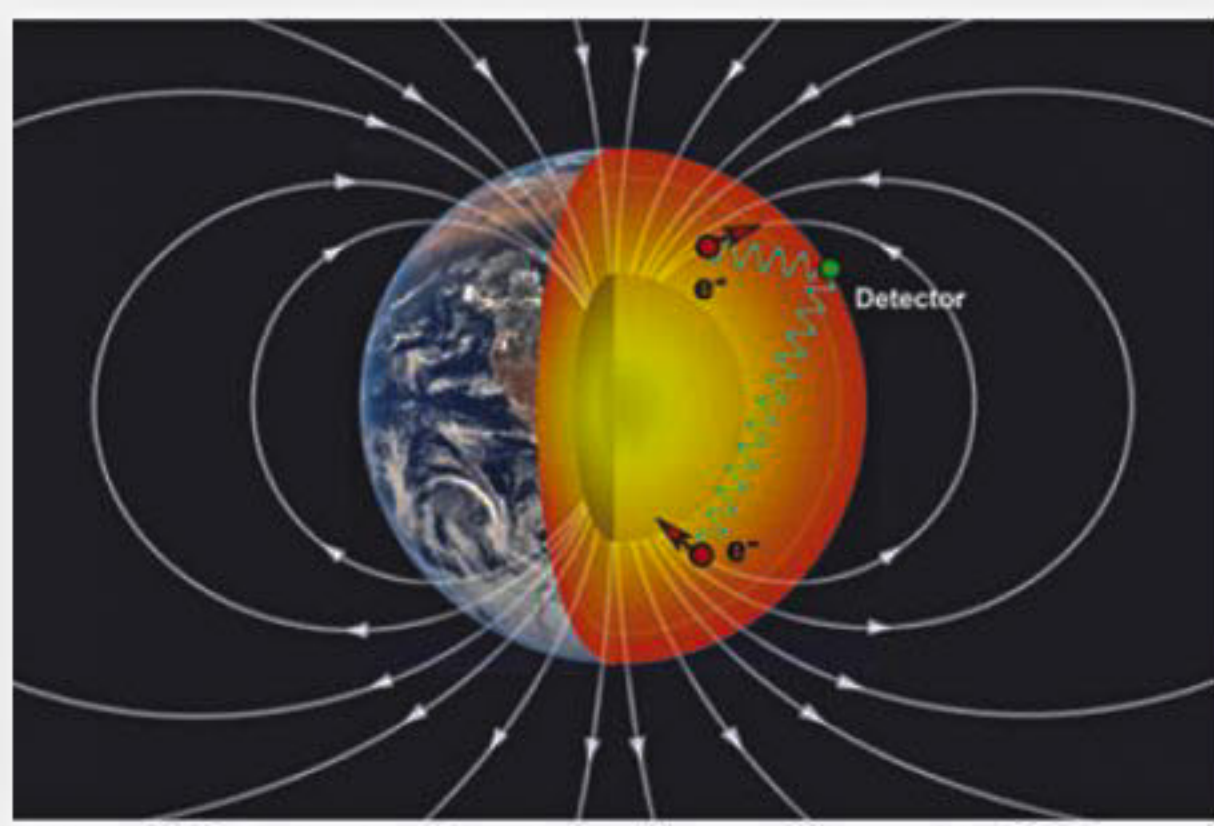
**I**N a breakthrough for the field of particle physics, Professor of Physics Larry Hunter and colleagues at Amherst College and The University of Texas at Austin have established new limits on what scientists call "long-range spin-spin interactions" between atomic particles. These interactions have been proposed by theoretical physicists but have not yet been seen. Their observation would constitute the discovery of a "fifth force of nature" (in addition to the four known fundamental forces: gravity, weak, strong and electromagnetic) and would suggest the existence of new particles, beyond those presently described by the Standard Model of particle physics.

The new limits were established by considering the interaction between the spins of laboratory fermions (electrons, neutrons and protons) and the spins of the electrons within Earth. To make this study possible, the authors created the first comprehensive map of electron polarization within Earth induced by the planet's geomagnetic field.

Hunter -- along with emeritus Amherst physics professor Joel Gordon; postdoctoral fellow Stephen Peck; student researcher Daniel Ang '15; and Jung-Fu "Afu" Lin, associate professor of geosciences at UT Austin -- co-authored a paper about their work that appears in this week's issue of the journal Science. The highly interdisciplinary research relies on geophysics, atomic physics, particle physics, mineral physics, solid-state physics and nuclear physics to reach its conclusions.

The paper describes how the team combined a model of Earth's interior with a precise map of the planet's geomagnetic field to produce a map of the magnitude and direction of electron spins throughout Earth. Their model was based in part on insights gained from Lin's studies of spin transitions at the high temperatures and pressures of Earth's interior.

Every fundamental particle (every electron, neutron and proton, to be specific), explained Hunter, has the intrinsic atomic property of "spin." Spin can be thought



This picture depicts the long-range spin-spin interaction (blue wavy lines) in which the spin-sensitive detector on Earth's surface interacts with geoelectrons (red dots) deep in Earth's mantle.

of as a vector -- an arrow that points in a particular direction. Like all matter, Earth and its mantle -- a thick geological layer sandwiched between the thin outer crust and the central core -- are made of atoms. The atoms are themselves made up of electrons, neutrons and protons that have spin. Earth's magnetic field causes some of the electrons in the mantle's minerals to become slightly spin-polarized, meaning the directions in which their spins point are no longer completely random, but have some net orientation.

Earlier experiments, including one in Hunter's laboratory, explored whether their laboratory spins prefer to point in a particular direction. "We know, for example, that a magnetic dipole has a lower energy when it is oriented parallel to the geomagnetic field and it lines up with this particular direction -- that is how a compass works," he explained. "Our experiments removed this magnetic interaction and looked to see if there might be some other interaction that would orient our experimental spins. One interpretation of this 'other' interaction is that it could be a long-range interaction between the spins in our apparatus, and the

electron spins within the Earth, that have been aligned by the geomagnetic field. This is the long-range spin-spin interaction we are looking for."

So far, no experiment has been able to detect any such interaction. But in Hunter's paper, the researchers describe how they were able to infer that such so-called spin-spin forces, if they exist, must be incredibly weak -- as much as a million times weaker than the gravitational attraction between the particles. At this level, the experiments can constrain "torsion gravity" -- a proposed theoretical extension of Einstein's Theory of General Relativity. Given the high sensitivity of the technique Hunter and his team used, it may provide a useful path for future experiments that will refine the search for such a fifth force. If a long-range spin-spin force is found, it not only would revolutionize particle physics but might eventually provide geophysicists with a new tool that would allow them to directly study the spin-polarized electrons within Earth.

"If the long-range spin-spin interactions are discovered in future experiments, geoscientists can eventually use such information to reliably understand the geochemistry and geophysics of the planet's interior," said Lin.

Possible future discoveries aside, Hunter said that he was pleased that this particular project enabled him to work with Lin. "When I began investigating spin transitions in the mantle, all of the literature led to him," he explained. "I was thrilled that he was interested in the project and willing to sign on as a collaborator. He has been a good teacher and has had enormous patience with my ignorance about geophysics. It has been a very fruitful collaboration."

Lin had his own take: "The most rewarding and surprising thing about this project was realizing that particle physics could actually be used to study the deep Earth."

Source: Science Daily



LONG

## Sauropod's outsize neck



Plant-eating dinosaurs called sauropods had the longest necks in the animal kingdom.

**H**OW did the largest of all dinosaurs evolve necks longer than any other creature that has ever lived? One secret: mostly hollow neck bones, researchers say.

The largest creatures to ever walk the Earth were the long-necked, long-tailed dinosaurs known as the sauropods. These vegetarians had by far the longest necks of any known animal. The dinosaurs' necks reached up to 50 feet (15 meters) in length, six times longer than that of the current world-record holder, the giraffe, and at least five times longer than those of any other animal that has lived on land.

"They were really stupidly, absurdly oversized," said researcher Michael Taylor, a vertebrate paleontologist at the University of Bristol in England. "In our feeble, modern world, we're used to thinking of elephants as big, but sauropods reached 10 times the size elephants do. They were the size of walking whales."

Amazing necks

To find out how sauropod necks could get so long, scientists analyzed other long-necked creatures and compared sauropod anatomy with that of the dinosaurs' nearest living relatives, the birds and crocodilians.

Source: Live Science



HIGH & MODIFYING WEATHER

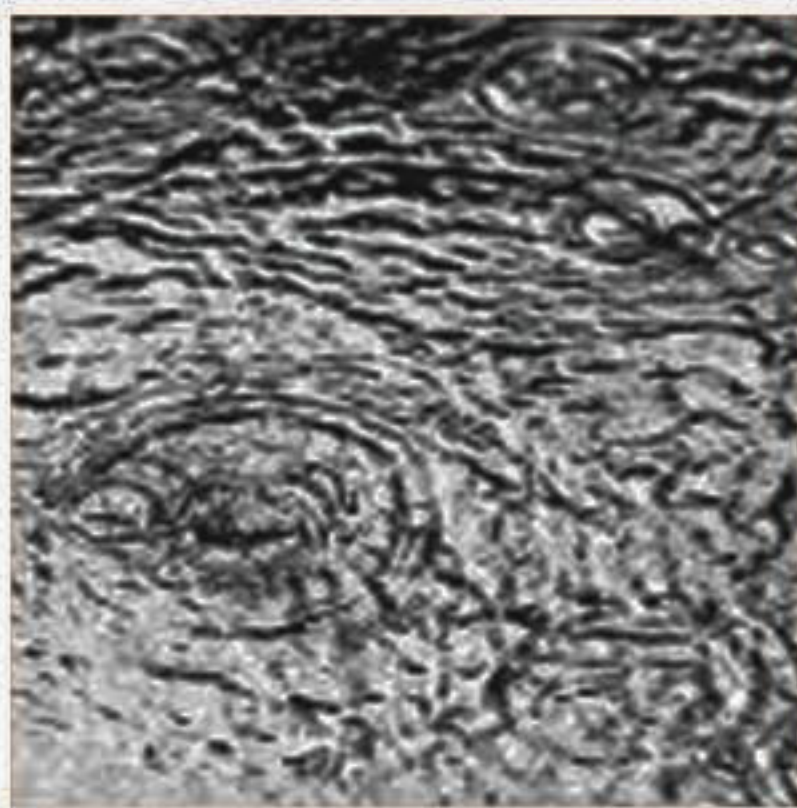
# Cloud seeding may prevent flooding

**I**NDONESIA is banking on an unusual strategy to prevent further flooding in its inundated capital Jakarta, and officials claim that they are already seeing positive results.

They are using 'cloud seeding' a weather modification technology often resorted to during drought. The method involves injecting clouds with substances that encourage the formation of ice crystals heavy enough to fall, thereby speeding up the production of rain. Rain is the last thing that Indonesia needs now, as it has been experiencing heavy rainfall since mid-January.

But Indonesian scientists believe that inducing rains to fall over the ocean before the rainclouds reach the city will help prevent further flooding in Jakarta. "We are mimicking nature. It is easy to make rain in most clouds above the sea. We found out that salt from sea water, which evaporates from the sea, accelerates the rain process because it encourages the cloud particles to adsorb water," Tri Handoko Seto, a top official of the Weather Modification Technical Unit of the Agency for the Assessment and Application of Technology, tells SciDev.Net.

Last month (26 January), military planes carrying tonnes of salt started the cloud seeding operation scattering salt onto rainclouds



Jakarta has suffered heavy flooding recently.

across the ocean. The operation is expected to last two months. The operation has come into the national spotlight recently because of the Indonesian government's claims that it had succeeded in decreasing Jakarta's rainfall rate, particularly from 26-29 January when local meteorologists had predicted heavier rains and flooding. "We have conducted an evaluation using the data in our radar device, which records cloud development and movement. From our analysis, cloud seeding contributed to the decrease of rainfall in Jakarta during this period," says Seto.

But Zev Levin, chair in atmospheric physics at Tel Aviv University in Israel, says that it is difficult to prove how much rain would have fallen before reaching

the city had the clouds not been seeded.

To prove the effectiveness of cloud seeding, Levin says, well designed experiments must be conducted based on robust statistical design with an unseeded control area and random allocation of seeding.

"In this case, Indonesia can't prove the success of their cloud seeding operation because they have no control area," says Levin. He adds that cloud seeding in Indonesia will do nothing or very little to modify the weather because tropical clouds are not easy to modify.

"The dynamics of the clouds dominate the rain process and any attempt to modify it will only play secondary role at best," says Levin. But Seto defends their programme and says that they will submit their work for publication in international journals to refute claims that their operations are not scientific.

Scientists produced the first evidence that cloud seeding can boost long-term rainfall in 2009. But they also urged caution over the technique due to unrealistic claims about its success and difficulties faced in comparing clouds to prove if the technique really works.

Source: SciDev.Net



STARRY PULL



DID YOU KNOW?



Researchers have discovered a new type of gravity wave, one that is shaped like a star.

SOURCE: LIVE SCIENCE

## Star-shaped gravity waves

Star-shaped waves can form in vibrating tanks of liquid oil, researchers say.

Learning more about such bizarre waves could shed light on counterparts that may exist elsewhere in nature, researchers added.

To uncover new, remarkable nonlinear waves, scientists experimented with circular and rectangular tanks containing about two-fifths of an inch (1 centimeter) of silicon oil. Researchers placed the tanks on shakers to vibrate the fluid. Scientists then observed that the liquid contained gravity waves oscillations due to gravity pulling downward and vibrations pushing upward.

## What is a Charango?

The charango is a small Andean stringed instrument of the lute family, 66 cm long, traditionally made with the shell of the



A Bolivian Charango

back of an armadillo. Primarily played in traditional Andean music, and is sometimes used by other Latin American musicians. Many contemporary charangos are now made with different types of wood. It typically has 10 strings in

five courses of 2 strings each. A charango player is called a charanguista. The instrument was invented in the

early 18th century in the Royal Audiencia of Charcas in what is now the Bolivia.

When the Spanish conquistadores came to South America, they brought the vihuela (an ancestor of the classical guitar) with them.