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SCIENCE & LIFE

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Cosmic ray theory challenged

THE confirmed origin of ordinary cosmic rays may need to be unconfirmed.

New data gathered by an instrument onboard a Russian spacecraft challenge the theory that most cosmic rays are fuelled by supernovas, the explosions created by dying stars.

"The mechanism for the acceleration of cosmic rays needs to be completely revised," says Piergiorgio Picozza, a physicist at the University of Rome Tor Vergata in Italy. Picozza is a coauthor of a March 3 paper in Science detailing the new observations of the Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics, or PAMELA, instrument.

Shock waves from supernovas, long thought to be the origin of cosmic rays, may not explain new data collected by a detector in orbit around Earth

Cosmic rays aren't actually rays. They're fast-moving particles that carry an extraordinary amount of energy and continuously bombard the Earth from every direction. The most popular explanation for the origin of these particles points to shock waves created by far-off supernovas, one of the few phenomena in the cosmos powerful enough to impart such energy.

According to that explanation, known as the diffusive shock acceleration mechanism, clouds of charged gas rush outward during a supernova and generate strong magnetic fields. These magnetic fields could accelerate charged particles to tremendous speeds and eject them into space.

Orbiting hundreds of kilometres above Earth, the PAMELA detector spent three years collecting cosmic ray particles mostly nuclei of hydrogen and helium with energies ranging from a billion to a trillion electron volts, which is comparable to the energy of protons in the biggest particle accelerator in the United States.

Magnetic fields in a supernova should accelerate both hydrogen and helium particles in the same way: Graph the mathematical description of this push, and the curve for each particle should have the same slope. But in the PAMELA data, Picozza found a difference in these slopes that a single shock wave can't explain.

"The two particles seem to be accelerated by different mechanisms," he says.

Scientists should investigate other astronomical objects as possible sources of cosmic rays, Picozza says. One place to look proposed by Russian physicists is in the novas, or smaller explosions, produced when white dwarf stars belch out energy. Another option is giant superbubbles of gas blown around the universe by stellar winds, says Picozza.

But Mikhail Malkov, a plasma physicist at the University of California, San Diego, who studies supernova shock waves, isn't ready to toss out the existing cosmic ray theory. "The data look statistically significant, but it's too early to say that the supernova acceleration model is in trouble. This statement is too strong," says Malkov.

Space telescopes peering into the remnants of supernovas have found lots of evidence over the years to support the supernova shock wave theory including gamma rays that reveal the structure of magnetic fields, and missing energy that could have been spent making cosmic rays.

Malkov says the difference between Picozza's hydrogen and helium curves is small, and it could be accounted for simply by tweaking the existing supernova model. Malkov hasn't worked out the details yet, but he suspects that PAMELA may be seeing cosmic rays created by a shock wave that wasn't completely uniform or a mishmash of particles released by two different supernovas.

Source: Science News

NOT JUST COPIES

Clone bugs have personality!

He pea aphid, Acyrthosiphon pisum, sucks nectar from a plant

TINY green insects known as pea aphids have individual behavior patterns, or "personalities," despite being clones of one another, scientists say. The researchers found differences in the way each individual responds to a threat.

The study was part of a "burgeoning" of scientific interest in animal personality variation, noted the investigators, with the University of Osnabrueck, Germany. But despite this trend, they added, few studies have been done on invertebrates, or simple animals without backbones.

Studies on "clonal invertebrates," which are all genetically identical and would thus be expected to show limited differences in behavior, are "nonexistent," they added, reporting their findings in the March 1 online issue of the journal Developmental Psychobiology.

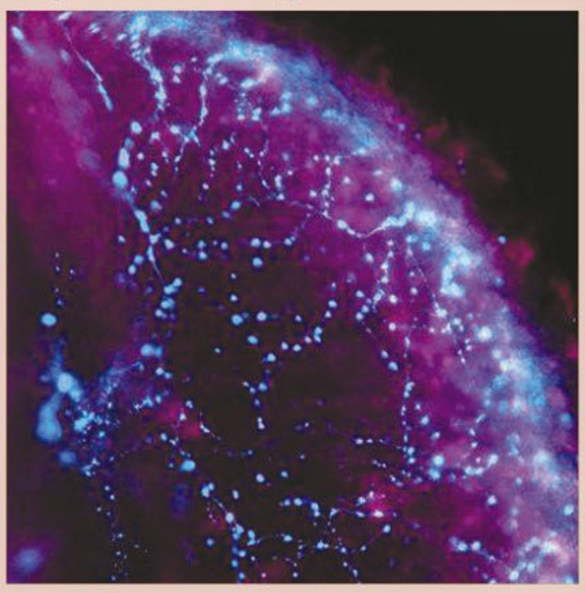
"This is surprising given the obvious advantages of using invertebrates/clones to tackle the crucial question why such consistent behavioral differences exist," they went on. Personality differences not attributable to genes are generally presumed to be due to the environment in which an organism formed, though there is also a growing appreciation of epigenetic factorschemical differences that are not genetic, but that influence gene activity.

Pea aphids, scientifically named Acyrthosiphon pisum, are pale little insects typically less than a sixth of an inch (half a centimeter) long that feed on pea plants and their relatives. A cluster of aphids infesting a given plant is typically a genetically identical, or clonal, group produced by one mother without sex, although aphids can also reproduce sexually at certain phases.

Source: World Science

METAL TRANSPORTER

Light-sensing neurons



This image shows blue-light sensing arousal neurons

A UC Irvine research team led by Todd C. Holmes has discovered a second form of phototransduction light sensing in cells that is derived from vitamin B2. This discovery may reveal new information about cellular processes controlled by light.

For more than 100 years, it had been believed that the phototransduction process was solely based on a chemical derived from vitamin A called retinal. Phototransduction is the conversion of light signals into electrical signals in photoreceptive neurons and underlies both image-forming and non-image-forming light sensing.

In discovering this new light-sensing phototransduction mechanism, the UCI scientists found that phototransduction can also be mediated by a protein called cryptochrome, which uses a B2 vitamin chemical derivative for light sensing. Cryptochromes are blue-light photoreceptors found in circadian and arousal neurons that regulate slow biochemical processes, but this is the first time they have been linked to rapid phototransduction.

Source: Science Daily

RISING Co2 LEVEL

Changing hydrological cycle

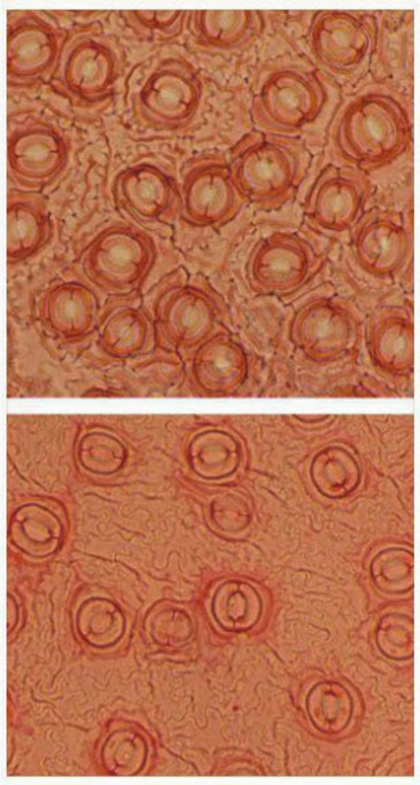
AS carbon dioxide levels have risen during the last 150 years, the density of pores that allow plants to breathe has dwindled by 34 percent, restricting the amount of water vapour the plants release to the atmosphere, report scientists from Indiana University Bloomington and Utrecht University in the Netherlands in an upcoming issue of the Proceedings of the National Academy of Sciences.

In a separate paper, also to be published by PNAS, many of the same scientists describe a model they devised that predicts doubling today's carbon dioxide levels will dramatically reduce the amount of water released by plants.

The scientists gathered their data from a diversity of plant species in Florida, including living individuals as well as samples extracted from herbarium collections and peat formations 100 to 150 years old.

"The increase in carbon dioxide by about 100 parts per million has had a profound effect on the number of stomata and, to a lesser extent, the size of the stomata," said Research Scientist in Biology and Professor Emeritus in Geology David Dilcher, the two papers' sole American coauthor. "Our analysis of that structural change shows there's been a huge reduction in the release of water to the atmosphere."

Most plants use a pore-like structure called stomata (singular: stoma) on the undersides of leaves to absorb carbon dioxide from the air. The carbon dioxide is used to build sugars, which can be used by the plant as energy or for incorporation into the plants' fibrous cell walls. Stomata also allow plants to "transpire"



Contemporary plants in Florida have fewer stomata than their ancestors did a few decades ago

water, or release water to the atmosphere. Transpiration helps drive the absorption of water at the roots, and also cools the plants in the same way sweating cools mammals.

If there are fewer stomata, or the stomata are closed more of the day, gas exchange will be limited -- transpiration included.

"The carbon cycle is important, but so is the water cycle," Dilcher said. "If transpiration decreases, there may be more moisture in the ground at first, but if there's less rainfall that may mean there's less moisture in ground eventually. This is part of the hyrdrogeologic cycle. Land plants are a crucially important part of it."

Dilcher also said less transpiration may mean the shade of an old oak tree may not be as cool of a respite as it used to be.

"When plants transpire they cool," he said. "So the air around the plants that are transpirating less could be a bit warmer than they have been. But the hydrogeologic cycle is complex. It's hard to predict how changing one thing will affect other aspects. We would have to see how these things play out."

While it is well known that long-lived plants can adjust their number of stomata each season depending on growing conditions, little is known about the long-term structural changes in stomata number or size over periods of decades or centuries.

"Our first paper shows connection between temperature, transpiration, and stomata density," Dilcher said. "The second paper really is about applying what we know to the future."

That model suggests that a doubling of today's carbon dioxide levels -- from 390 parts per million to 800 ppm -- will halve the amount of water lost to the air, concluding in the second paper that "plant adaptation to rising CO2 is currently altering the hydrological cycle and climate and will continue to do so throughout this century."

Source: Science Daily

LOOK INTO POOP

What are bats' favourite foods?

WANT to know what bats eat? Just remember what goes in must come out.

That's the principle used by researchers from the University of Bristol in the U.K. and the Biodiversity Institute of Ontario, Canada. The scientists wanted to know which insects top the list of bats' favorite food. So they collected four months' worth of bat poop (also known as guano) from roosts in Southern Ontario. A genetic analysis of insect DNA extracted from the guano reveals that the flying mammals like eating insects from aquatic environments.

"This technology is very new," study author Elizabeth Clare of the University of Bristol said in a statement. "It gives us an entirely new insight into the bats' behavior. Instead of finding they ate a moth or a mayfly, we now know exactly what species of insect it was."

"It's a very noninvasive way of tracking their behavior," Clare added. "A bit like looking through someone's rubbish bin to see where they shop."

The bats studied were Myotis lucifugus or little brown bats which are currently threatened by a deadly fungus called white-nose syndrome. The fungus powders the noses of bats as they hibernate, waking them from their slumber and evidently depleting their energy stores, ultimately killing them.

In the current study, published March 3 in the journal Molecular Ecology, researchers wanted to know more about the environment supporting these threatened bats. They extracted insect DNA from guano collected between May and August at three bat roosts. They then matched small regions of the extracted DNA to databases of known insect DNA to identify the species that make up bat meals.

Source: Live Science

On the menu for little brown bats: Local, aquatic

BELCHING BLACK HOLE

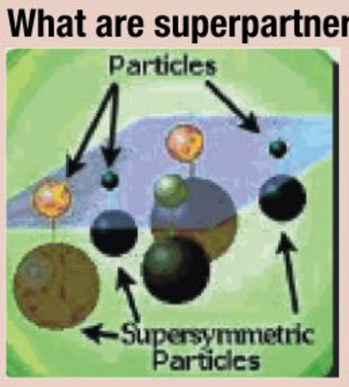
Last gasp of a galaxy

SOURCE: WORLD SCIENCE

Artist's conceptual of the environment around the supermassive black hole at the center of Mrk 231. The broad outflow seen in the Gemini data is shown as the fan-shaped wedge at the top of the accretion disk around the black hole. This side-view is not what is seen from the Earth where we see it 'looking down the throat' of the outflow. A similar outflow is probably present under the disk as well and is hinted at in this illustration. The total amount of material entrained in the broad flow is at least 400 times the mass of the Sun per year. Note that a more localized, narrower jet is shown, this jet was known prior to the Gemini discovery of the broader outflow featured here.

DID YOU KNOW?

What are superpartners of particles?



In particle physics, a superpartner (also sparticle) is a hypothetical elementary particle. Supersymmetry is one of the synergistic bleeding-edge theories in current high-energy physics which predicts the existence of these "shadow" particles. The word superpartner is a portmanteau of the words supersymmetry and partner (sparticle is a portmanteau of supersymmetry and particle).