Superfluid dynamics unlocked

IT has been 100 years since the discovery of superconductivity, a state achieved when mercury was cooled, with the help of liquid helium, to nearly the coldest temperature achievable to form a superfluid that provides no resistance to electrons as they flow through it.

During that century, scientists have struggled to find a precise mathematical explanation of why and how this strange fluid behaves as it does. Liquid helium-4 itself becomes a superfluid when cooled to within a few degrees of absolute zero on the Kelvin scale (minus 273 Celsius or minus 460 Fahrenheit), and the resulting lack of viscosity allows it to seem to defy gravity, flowing up and over the sides of a container.

Now a team led by a University of Washington physicist, using the most powerful supercomputer available for open science, has devised a theoretical framework that explains the real-time behavior of superfluids that are made of fermions -- subatomic particles such as electrons, protons and neutrons that are basic building blocks of nature.

Such superfluids are found in neutron stars, which rotate between one and 1,000 times a second. These stars, also called pulsars, have 50 percent greater mass than the sun but are packed so densely that one can occupy an area only about the size of a city such as Seattle, said Aurel Bulgac, a UW physics professor and lead author of a paper in the June 10 edition of Science that details the work.

A phenomenon called von Karman vortices in clouds. The vortices are similar to those that form in superfluids.

As a neutron star rotates, the superfluid on the surface behaves quite differently than a liquid would on the surface of Earth. As the rotational speed increases the fluid opens a series of small vortices. As the vortices assemble into triangular patterns, the triangles build a lattice structure within the superfluid.

"When you reach the correct speed, you'll create one vortex in the middle," Bulgac said. "And as you increase the speed, you will increase the number of vortices. But it always occurs in steps."

Similar behavior can be recreated in a laboratory using a vacuum chamber and a laser beam to create a high-intensity electrical field that will cool a small sample, perhaps 1 million atoms, to temperatures near absolute zero. A "laser spoon" then can stir the superfluid fast enough to create vortices.

In trying to understand the odd behavior, scientists have attempted to devise descriptive equations, as they might to describe the swirling action in a cup of coffee as it is stirred, Bulgac said. But to describe the action in a superfluid made of fermions, a nearly limitless number of equations is needed. Each describes what happens if just one variable -- such as velocity, temperature or density -- is changed. Because the variables are linked, if one changes others will change as well.

The challenge, Bulgac said, was to formulate the proper mathematical problem and then find a computer that could work through the problem as the number of variable changes reached 1 trillion or more. To reach its solution, the team in the last year used the JaguarPF computer at Oak Ridge National Laboratory in Tennessee, one of the largest supercomputers in the world, for the equivalent of 70 million hours, which would require almost 8,000 years on a single-core personal computer (JaguarPF has nearly a quarter-million cores).

"This tells you the complexity of these calculations and how difficult this is," he said.

The researchers also found through their calculations that by increasing the speed at which the fluid was stirred, eventually it would lose its superfluid properties -- though not as soon as had been previously hypothesized. Video representations of the results of the massive numerical simulations are athttp:// www.phys.washington.edu/groups/qmbnt/UFG.

The work means that researchers can "to some extent" study the properties of a neutron star using computer simulations, Bulgac said. It also opens new directions of research in cold-atom physics.

"This is a pretty major step forward in studying these dynamic processes," he said.

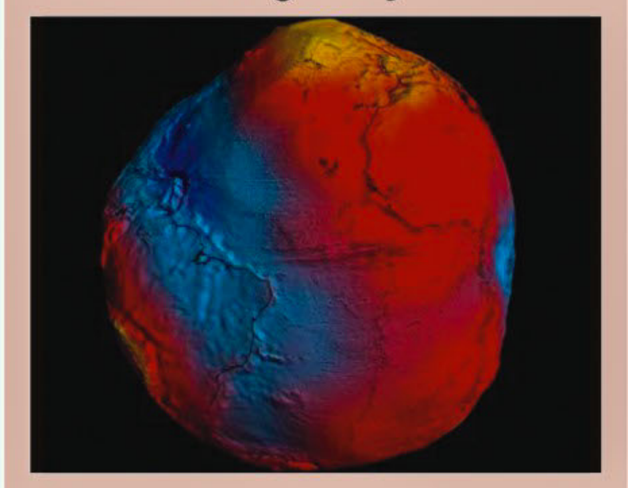
Co-authors are Yuan-Lung Luo of the UW, Piotr Magierski of the Warsaw University of Technology in Poland; Kenneth Roche of the Pacific Northwest National Laboratory in Richland, Wash.; and Yongle Yu of China's State Key Laboratory of Magnetic Resonance, Atomic and Molecular Physics. Magierski and Roche also have affiliate UW physics appointments.

The research was funded by the U.S. Department of Energy, the U.S. National Science Foundation, the Polish Ministry of Science and the Chinese National Science Foundation.

Source: Science Daily

GRAVITATIONAL PORTRAIT

A matter of gravity



Yellow and red represent some of the sharp deviations from the average pull of Earth's gravitational field, gathered in this new map by the European GOCE satellite.

As seen by a supersensitive gravity-detecting satellite, Earth isn't a pale blue dot. It's a colorful, irregular lump. Kind of like a tuber.

"Rotating potato I don't like this word," said Roland Pail, a geoscientist at the Technical University of Munich. He and other researchers unveiled the new map of the Earth's gravity field on March 31 at a scientific workshop in Munich.

Yet a rainbow potato it is. This image represents a sort of theoretical sea level known as the "geoid" a surface where the ocean would rest if not pushed around by internal currents, tides and the weather.

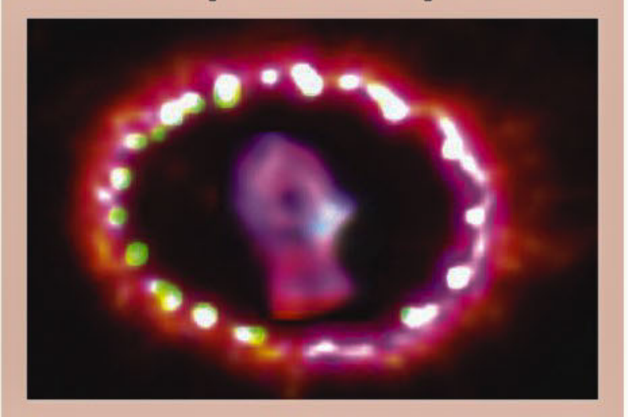
Gravity varies from place to place because of many factors, such as the presence of mountain ranges, the bulge around Earth's equator, and the moon's gravitational influence. The new snapshot comes from the European Space Agency's GOCE satellite, launched in 2009 to map the geoid. GOCE dances along at the top of the atmosphere, using six special accelerometers to measure, many times a second, how the Earth's gravity tugs on the spacecraft.

A highly accurate gravity map will allow researchers to fine-tune their understanding of ocean currents, sea level height, ice caps and other changing parts of the planet.

Source: Science News

'GUTS' OF A STAR

Closest Supernova explodes



The closest supernova explosion seen in almost 400 years, it is located in the Large Magellanic Cloud.

In 1987, light from an exploding star in a neighboring galaxy, the Large Magellanic Cloud, reached Earth. Named Supernova 1987A, it was the closest supernova explosion witnessed in almost 400 years, allowing astronomers to study it in unprecedented detail as it evolves.

Today a team of astronomers announced that the supernova debris, which has faded over the years is now brightening. This shows that a different power source has begun to light the debris, and marks the transition from a supernova to a supernova remnant.

"Supernova 1987A has become the youngest supernova remnant visible to us," said Robert Kirshner of the Harvard-Smithsonian Center for Astrophysics (CfA).

Kirshner leads a long-term study of SN 1987A with NASA's Hubble Space Telescope. Since its launch in 1990, Hubble has provided a continuous record of the changes in SN 1987A.

As shown in the accompanying image, SN 1987A is surrounded by a ring of material that blew off the progenitor star thousands of years before it exploded. The ring is about one light-year (6 trillion miles) across. Inside that ring, the "guts" of the star are rushing outward in an expanding debris cloud.

Most of a supernova's light comes from radioactive decay of elements created in the explosion. As a result, it fades over time. However, the debris from SN 1987A has begun to brighten, suggesting that a new power source is lighting it.

Source: Science Daily

DREAM ISLAND

Marvels in Madagascar

OBAIDUR RAHMAN

SINCE 1999, almost on weekly basis, scientists from World Wildlife Fund have discovered an array of 615 new species, some of which a colorful and lovable while some are bizarre and downright scary. And this decade long finding, which discovered world's tiniest primate as well as a color-altering gecko, also states that these magnificent new species as well as plants are under threat, chiefly because of the increasing rate of destruction of Madagascar's forest. According to a latest report by WWF, this island nation, located in the Indian Ocean off the southeastern coast of Africa, now houses newly discovered species of 41 mammals, 385 plants, 69 amphibians, 61 reptiles, 17 fish and 42 invertebrates (animals without any backbone).

Few words are in order regarding why so many new species in Madagascar at the first place. It is believed that Madagascar was separated from Africa and the Indian subcontinent sometime between 80 million to 100 million years ago. And this geographical separation turned the island into a jewel in the realm of biodiversity allowing Madagascar's plant and animal residents to evolve into fantastical forms and not only that, experts suggest that about 70 percent of its species are also unseen anywhere else on the planet! And the recent finding of the WWF is simply a reflection of that. And in the words of Nanie Ratsifandrihamanana, WWF Madagascar's conservation director, "All the species are so special, and many are unique to Madagascar. They don't exist anywhere else in the world".

The concentrated area for this study was PK32-Ranobe which is basically a biological hotspot of biodiversity and an area that is almost completely surrounded by mining concessions. Amongst key discoveries include, a 10cm long (4inch) Berthe's mouse lemur (Microcebus berthae) and weighing in at just about an ounce (30 grams) which clearly makes it world's smallest known primate. In 1992, there were only two known species of mouse lemurs but since then the number jumped into 15 species. And also there's the 4cm-long Komac's golden orb spider (Nephila komaci) that spins webs up to a meter in diameter, the cork bark leaf-tailed gecko that looks just like the bark of a tree, allowing it to hide quite effortlessly from predators. And the Tahina palm (Tahina spectabilis) a massive fan palm which flowers just once in a lifetime. Aside from these, the colorful chameleon species, Furcifer timoni with their vibrant "glam rock attire", Boophis bottae, one of the 69 amphibians discovered over the last 11 years, Calumma tarzan, a new species of chameleon found in the central and Eastern Madagascar, the spotted Madagascar rainbow-fish, Bedotia marjejy and the bright pink snake (Liophidium pattoni) that grows about 16 inches (40 centimeters) and preys on small rodents and lizards, all of which that truly stands out amongst the newly discoveries.

Speckled with what looks like glam rock makeup, the chameleon Furcifer timoni was recently discovered African island nation of Madagascar

But unfortunately, it's not all good news. Many of the creatures discovered are already endangered and drastically losing their habitat. Madagascar's forests, from the year 1950 to 1990, were basically cleared at a rate of about 2% a year. And according to WWF, the island has lost 90 percent of its original forest cover.

Obaidur Rahman is a freelance science writer & contributor to Science and Life

INSIDE BLACK BOX

When brain switch dims...

New 3-D images reveal for the first time what happens inside the brain when a person loses consciousness, suggesting the mysterious sleeplike state occurs as electrical activity deep in the brain dims and connections between certain neurons suddenly break down.

"We have produced what I think is the first video in existence in the entire world of [the brain of] a patient being anesthetized," said study researcher Brian Pollard, of the University of Manchester. "We are seeing different parts of the brain, different areas, being activated and deactivated."

Loss of consciousness occurs when the brain is no longer aware of one's surroundings and so the body stops reacting to the world around it. Scientists and doctors aren't sure how this happens, but distinguish it from consciousness, or the ability to understand, be self-aware and think in the unique way that humans do. [Top 10 Mysteries of the Mind]

Previous theories, by Dr. Susan Greenfield of the University of Oxford, suggest that our brains are on a "dimmer switch," a theory supported by the new data. Here's how it works: When we're awake, certain groups of brain cells interact and work together to decipher information sent to the brain. When this "dimming switch" gets turned down as would happen with an anaesthetic drug these brain-cell interactions don't work as well together and communication between the groups is inhibited.

A new imaging method allowed the researchers to monitor the electrical activity deep inside the brain in real time through 32 electrodes on the head of each study participant. Because the electrodes monitor this activity 100 times per second, the researchers were literally able to watch as patients went from awake to an unconscious state.

Source: Live Science

'WILD GOOSE'!

Guess what's it about

Source: Live Science

This is a tough one, but take a guess before you read the hints.

Hint No. 1: The perspective is all wrong.

Hint No. 2: It's got nothing to do with smoke. And it's not in outer space. Read on for the answer …

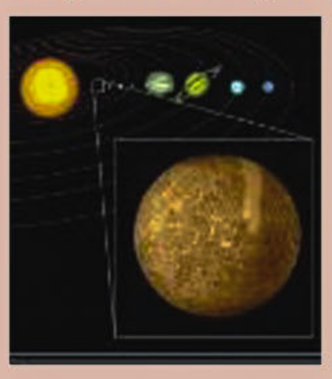
It's lightning. From above.

In January, the European Space Agency's Paolo Nespoli took the photo, of lightning overBrazil , from the International Space Station.

Lightning sometimes shoots out the tops of clouds into the highest reaches of the atmosphere, at the very edge of space. Thunderstorms also hurl antimatter into space.

DID YOU KNOW?

Why is Mercury forgotten planet?



Mercury can claim the title for the "weirdest" planet in the solar system, apart from being the smallest and the innermost. It has the wildest temperature extremes - from 800'c to to 300'c and drifts from being the nearest to being the farthest from the sun. Reaching mercury poses significant challenges as the planet orbits close to the sun. Hence, it is regarded as the forgotten planet in the solar system.

Reconstruction of the brain during the onset of anaesthesia. This particular frame shows the brain in an anaesthetised state following global conductivity changes.