INTERNATIONAL YEAR OF LIGHT 2015

100 Million Stars in the Andromeda galaxy.

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Weekly news from around the world compiled by Dr. Ilias Fernini

Inside this issue:

Scientists report seasonal changes on Sun

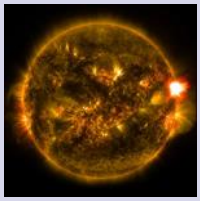
Researchers at NCAR (the National Center for Atmospheric Research) reported on April 7, 2015 that our sun undergoes a type of seasonal variability that waxes and wanes over nearly two years. The researchers say this two-year cycle affects peaks and valleys in the better-known 11-year cycle of the sun. It acts to sometimes amplify – and sometimes weaken – the solar storms that can buffet Earth's atmosphere. Two-year solar variations appear to be driven by changes in the bands of strong magnetic fields in the sun's northern and southern hemispheres. The study is published this week in the journal Nature Communications.

Scott McIntosh, lead author of the new study and director of NCAR's High Altitude Observatory, said:

What we're looking at here is a massive driver of solar storms.

He said scientists are trying to understand how the rotation of the sun's deep interior drives these activity bands on the sun, with the goal of improving forecasts of space weather events. These events have the potential to affect our human satellite operations, communications, power grids, and other technologies.

On the sun, the magnetic activity bands move within the sun's northern and southern hemispheres. The scientists found that ...Read More...



An M-class solar flare erupts from the right side of the sun in this January 2015 image from NASA's Solar Dynamics Observatory. NCAR scientists say these sorts of storms wax and wane in a two-year cycle.

Large Hadron Collider is back up!

After problems that delayed its restart in March, the Large Hadron Collider (LHC), the world's most powerful particle accelerator, was restarted on Sunday (April 6) following two years of intense maintenance and upgrade.

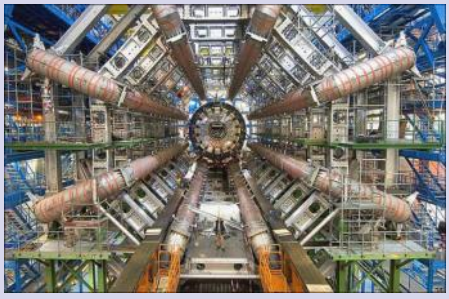
The LHC, operated by the European Organization for Nuclear Research (CERN), is located in a tunnel between Lake Geneva and the Jura mountain range on the Franco-Swiss border.

The upgrade was intended to nearly double the collider's maximum collision capacity.

Scientists at CERN said particles have successfully been moving in two directions, at just under the speed of light, inside the LHC's 17 mile (27 km) ring of parallel pipes. It will be at least another month until actual collisions start, but they'll happen with nearly double the energy as during the LHC's first run.

The LHC generates up to 600 million particles per second, with a beam circulating for 10 hours, traveling more than 6 billion miles (more than 10 billion kilometers) – that's about the distance from Earth to Neptune and back again.

Physicists hope that the LHC will help answer questions concerning the basic laws governing the interactions and forces among fundamental particles, the building blocks ...***Read More***...



The large Hadron Collider

Tunneling across a tiny gap

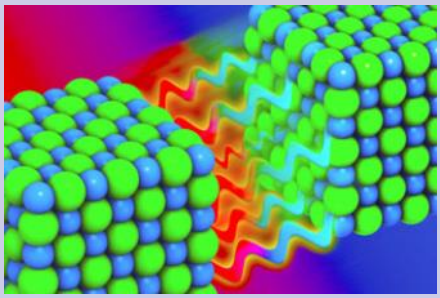
Conduction and thermal radiation are two ways in which heat is transferred from one object to another: Conduction is the process by which heat flows between objects in physical contact, such as a pot of tea on a hot stove, while thermal radiation describes heat flow across large distances, such as heat emitted by the sun.

These two fundamental heat-transfer processes explain how energy moves across microscopic and macroscopic distances. But it's been difficult for researchers to ascertain how heat flows across intermediate gaps.

Now researchers at Massachusetts Institute of Technology (MIT), the Univ. of Oklahoma and Rutgers Univ. have developed a model that explains how heat flows between objects separated by gaps of less than a nanometer. The team has developed a unified framework that calculates heat transport at finite gaps, and has shown that heat flow at sub-nanometer distances occurs not via radiation or conduction, but through "phonon tunneling."

Phonons represent units of energy produced by vibrating atoms in a crystal lattice. For example, a single crystal of table salt contains atoms of sodium and chloride, arranged in a lattice pattern. Together, the atoms vibrate, creating mechanical waves that can transport heat across the lattice.

Normally these waves, or phonons, are only able to carry heat within, and not between, materials. However, the new research shows that phonons can reach across a gap as small ...***Read More***...



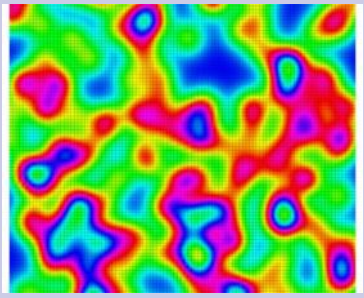
This illustration depicts phonons "tunneling" from one lattice of sodium chloride to another. New research shows that phonons can reach across a gap as small as a nanometer, "tunneling" from one material to another to enhance heat transport. Image: Jose-Luis Olivares/MIT

A potential Rosetta stone of high temperature superconductivity

High purity single crystals of superconducting material (CeCoIn5) with the highest observed superconducting temperature for a cerium-based material enabled investigation of the relationship among magnetism, superconductivity, and disorder by strategic substitution of certain atoms with others (dopants) in the superconductor.

Just as the Rosetta Stone has the same message written in three different scripts giving scholars key insights into ancient languages, the subject material (CeCoIn5), by virtue of its high purity, allows study of the interplay between magnetism, superconductivity, and disorder in three different classes of unconventional superconductors (cuprates, pnictides, and heavy fermions). The versatile model system could help researchers decipher the complex emergent phenomena in different classes of unconventional superconductors and in the development of a complete theory for the high-temperature superconductivity.

Superconductivity enables the flow of electricity without any loss of energy, but this extremely low temperature phenomenon disappears above a critical temperature (Tc). Since the discovery of a new class of materials in 1986, known as unconventional superconductors, that preserves superconductivity at temperatures much higher than previously known conventional superconductors, the scientific community has been on the quest to learn about the complete mechanisms for the unconventional superconductivity to enable the design of superconducting materials that ...***Read More***…



Numerical simulation of the magnetic inhomogeneity (red = magnetism, blue = superconductivity) caused by replacing 1% of the indium atoms in a superconductor (CeCoIn5) with cadmium atoms. The field of view is approximately 100 nanometers along each edge. Credit: Seo et al., Nature Physics, 10, February 2014

SESAME passes an important milestone at CERN

The SESAME project has reached an important milestone: the first complete cell of this accelerator for the Middle East has been assembled and successfully tested at CERN.

SESAME is a synchrotron light source under construction in Jordan. It will allow researchers from the region to investigate the properties of innovative materials, biological processes and cultural artefacts. SESAME is a unique joint venture that brings together scientists from its Members: Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority and Turkey. Not only is SESAME an important scientific project, it is also helping to build bridges between diverse cultures in a part of the world that usually hits the headlines for its conflicts.

CERN has been a strong partner to SESAME, providing technical expertise for the design and procurement of accelerator components. In particular, CERN is responsible for the magnets of the SESAME storage ring and their powering scheme, under a project largely funded by the European Commission (FP7 CESSAMag).

Within this project, CERN has been collaborating with SESAME to design, test and characterize the components of the magnetic system, which is now in production. The main contracts have been split among different companies in Cyprus, France, Israel, Italy, Spain, Switzerland, Turkey and the UK, with additional in-kind support (material and personnel) from Iran, Pakistan and Turkey...***Read More***...

An engineer tests the installation of a vacuum chamber for SESAME, at CERN's magnet-testing facility SM18. Credit: Maximilien Brice/CERN

There Could Be Lava Tubes on the Moon, Large Enough for Whole Cities

Every year since 1970, astronomers, geologists, geophysicists, and a host of other specialists have come together to participate in the Lunar and Planetary Science Conference (LPCS). Jointly sponsored by the Lunar and Planetary Institute (LPI) and NASA's Johnson Space Center (JSC), this annual event is a chance for scientists from all around the world to share and present the latest planetary research concerning Earth's only moon.

This year, one of the biggest attention-grabbers was the findings presented on Tuesday, March 17th by a team of students from Purdue University. Led by a graduate student from the university's Department of Earth, Atmospheric and Planetary Sciences, the study they shared indicates that there may be stable lava tubes on the moon, ones large enough to house entire cities.

In addition to being a target for future geological and geophysical studies, the existence of these tubes could also be a boon for future human space exploration. Basically, they argued, such large, stable underground tunnels could provide a home for human settlements, shielding them from harmful cosmic radiation and extremes in temperature.

Lava tubes are natural conduits formed by flowing lava that is moving beneath the surface as a result of a volcanic eruption. As the lava moves, the outer edges of it cools, forming a hardened, channel-like crust which is left behind once the lava flow stops. For some time, Lunar scientists have been speculating as to whether or not lava flows happen on the Moon, as evidenced by the presence of sinuous rilles on the surface.

Sinuous rilles are narrow depressions in the lunar surface that resemble channels, and have a curved paths that meanders across the landscape like a river valley. It is currently believed that these rilles are ...***Read More***...

Rima Ariadaeus, a linear rile (a surface channel thought to be formed by lava) on the Moon's surface, as photographed from Apollo 10. Credit: NASA

The solar system and beyond is awash in water

As NASA missions explore our solar system and search for new worlds, they are finding water in surprising places. Water is but one piece of our search for habitable planets and life beyond Earth, yet it links many seemingly unrelated worlds in surprising ways.

"NASA science activities have provided a wave of amazing findings related to water in recent years that inspire us to continue investigating our origins and the fascinating possibilities for other worlds, and life, in the universe," said Ellen Stofan, chief scientist for the agency. "In our lifetime, we may very well finally answer whether we are alone in the solar system and beyond."

The chemical elements in water, hydrogen and oxygen, are some of the most abundant elements in the universe. Astronomers see the signature of water in giant molecular clouds between the stars, in disks of material that represent newborn planetary systems, and in the atmospheres of giant planets orbiting other stars.

There are several worlds thought to possess liquid water beneath their surfaces, and many more that have water in the form of ice or vapor. Water is found in primitive bodies like comets and asteroids..***Read More***..

NASA is exploring our solar system and beyond to understand the workings of the universe, searching for water and life among the stars. Credit: NASA

Accelerating universe? Not so fast

A University of Arizona-led team of astronomers found that the type of supernovae commonly used to measure distances in the universe fall into distinct populations not recognized before; the findings have implications for our understanding of how fast the universe has been expanding since the Big Bang.

Certain types of supernovae, or exploding stars, are more diverse than previously thought, a University of Arizona-led team of astronomers has discovered. The results, reported in two papers published in the Astrophysical Journal, have implications for big cosmological questions, such as how fast the universe has been expanding since the Big Bang.

Most importantly, the findings hint at the possibility that the acceleration of the expansion of the universe might not be quite as fast as textbooks say.

The team, led by UA astronomer Peter A. Milne, discovered that type Ia supernovae, which have been considered so uniform that cosmologists have used them as cosmic "beacons" to plumb the depths of the universe, actually fall into different populations. The findings are analogous to sampling a selection of 100-watt light bulbs at the hardware store and discovering that they vary in brightness.

"We found that the differences are not random, but lead to separating Ia supernovae into two groups, where the group that is in the minority near us are in the majority at large distances—and thus when the universe was younger," said Milne, an associate astronomer with the UA's Department of Astronomy and Steward Observatory. "There are different ... ***Read More***….

An optical image of galaxy M101 obtained by Adam Block with the UA's Mt. Lemmon Sky Center. Credit: Adam Block

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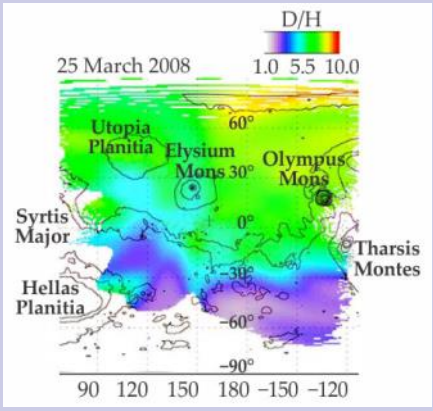
The evolution of hydrogen on Mars

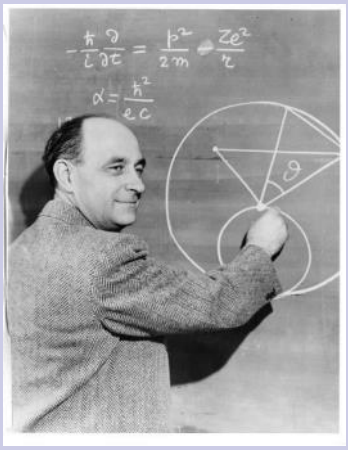
Mars is slowly losing its atmosphere. Lighter water escapes faster than heavier water, and the large enrichment in the Martian atmosphere's deuterium/hydrogen ratio—relative to that in Earth's oceans—is evidence for part of the loss. The ratio for Mars was first measured from Doppler-shifted molecular absorption lines taken by the Keck Observatory in Hawaii more than a quarter century ago. Using data from a survey that ran from March 2008 through January 2014, a team led by NASA's Geronimo Villanueva has created spatially and temporally resolved maps of D/H on Mars. The researchers adopted the same remote spectroscopic approach used to obtain the older results, but instead of measuring a hemispherically averaged value, they stepped the entrance slit of an IR spectrometer across the planet ...***Read More***...



Beyond "Fermi's Paradox" I: A Lunchtime Conversation-Enrico Fermi and Extraterrestrial Intelligence

It's become a kind of legend, like Newton and the apple or George Washington and the cherry tree. One day in 1950, the great physicistEnrico Fermi sat down to lunch with colleagues at the Fuller Lodge at Los Alamos National Laboratory in New Mexico and came up with a powerful argument about the existence of extraterrestrial intelligence, the so-called "Fermi paradox". But like many legends, it's only partly true. Robert Gray explained the real history in a recent paper in the journal Astrobiology.

Enrico Fermi was the winner of the 1938 Nobel Prize for physics, led the team that developed the world's first nuclear reactor at the University of Chicago, and was a key contributor to the Manhattan Project that developed the atomic bomb during World War II. The Los Alamos Lab where he worked was founded as the headquarters of that project. The line of reasoning often attributed to Fermi, in his lunchtime conversation, runs like this: There may be many habitable Earth-like planets in our Milky Way galaxy. If intelligent life and technological civilization arise on any one of them, that civilization will eventually invent a means of interstellar ...***Read More***…



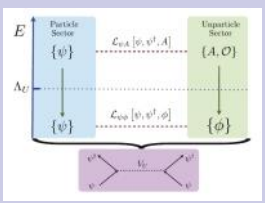
Nuclear physicist Enrico Fermi won the 1938 Nobel Prize for a technique he developed to probe the atomic nucleus. He led the team that developed the world's first nuclear reactor, and played a central role in the Manhattan Project that developed the atomic bomb during World War II. In the debate over extraterrestrial intelligence, he is best known for posing the question 'Where is everybody?' during a lunchtime discussion at Los Alamos National Laboratory. His question was seen as the basis for the "Fermi Paradox". Credit: Smithsonian Institution Archives.

Unparticles may provide a new path to superconductivity

Physicists have proposed that a hypothetical form of matter called "unparticles" may play a key role in mediating superconductivity—the ability of certain materials to conduct electricity with zero resistance.

Physicists James LeBlanc and Adolfo Grushin at the Max Planck Institute for the Physics of Complex Systems in Dresden (LeBlanc is now with the University of Michigan in Ann Arbor) have published a paper on their proposal of unparticle-mediated superconductivity in a recent issue of the New Journal of Physics.

"Understanding all forms of superconductivity remains one of the holy grails of modern physics," Grushin told Phys.org. "Proposing new ways of how this astonishing phenomena ..***Read More***..



Unparticles may emerge when, at high energies, the particle sector couples to the unparticle sector. Physicists plan to look for the signatures of unparticles in future experiments, possibly by looking for strange superconducting behavior. Credit: LeBlanc and Grushin. CC-BY-3.0