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This Week’s Sky at a Glance, Mar. 17-23, 2018

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Stephen Hawking, best-known physicist of his time, has died

Stephen Hawking, whose brilliant mind ranged across time and space though his body was paralyzed by disease, died Wednesday. He was 76.

Hawking died at his home in Cambridge, England, according to a statement by the University of Cambridge.

The best-known theoretical physicist of his time, Hawking wrote so lucidly of the mysteries of space, time and black holes that his book, "A Brief History of Time," became an international best-seller, making him one of science's biggest celebrities since Albert Einstein.

"He was a great scientist and an extraordinary man whose work and legacy will live on for many years," his children Lucy, Robert and Tim said in a statement. "His courage and persistence with his brilliance and humour inspired people across the world. He once said, 'It would not be much of a universe if it wasn't home to the people you love.' We will miss him forever."

Even though his body was attacked by amyotrophic lateral sclerosis, or ALS, when Hawking was 21, he stunned doctors by living with the normally fatal illness for more than 50 years. A severe attack of pneumonia in 1985 left him breathing through a tube, forcing him to communicate through an electronic voice synthesizer that gave him his distinctive robotic monotone.

But he continued his scientific work, appeared on television and married for a second time. As one of Isaac Newton's successors as Lucasian Professor of Mathematics at Cambridge University, Hawking was involved in the search for the great goal of physics—a "unified theory."

Such a theory would resolve the contradictions between Einstein's theory of relativity, which describes the laws of gravity that govern the motion of large objects like planets, and the quantum mechanics theory.

Researchers demonstrate existence of new form of electronic matter

Researchers have produced a "human scale" demonstration of a new phase of matter called quadrupole topological insulators that was recently predicted using theoretical physics. These are the first experimental findings to validate this theory.

The researchers report their findings in the journal Nature.

The team's work with QTIs was born out of the decade-old understanding of the properties of a class of materials called topological insulators. "TIs are electrical insulators on the inside and conductors along their boundaries, and may hold great potential for helping build low-power, robust computers and devices, all defined at the atomic scale," said mechanical science and engineering professor and senior investigator Gaurav Bahl.

The uncommon properties of TIs make them a special form of electronic matter. "Collections of electrons can form their own phases within materials. These can be familiar solid, liquid and gas phases like water, but they can also sometimes form more unusual phases like a TI," said co-author and physics professor Taylor Hughes.

TIs typically exist in crystalline materials and other studies confirm TI phases present in naturally occurring crystals, but there are still many theoretical predictions that need to be confirmed, Hughes said.

One such prediction was the existence of a new type of TI having an electrical property known as a quadrupole moment. "Electrons are single particles that carry charge in a material," said physics graduate student Wladimir Benalcazar. "We found that electrons in crystals can collectively arrange to give rise not only to charge dipole units - that is, pairings of positive and negative charges - but also high-order multipoles in which four or eight charges are brought together into a unit. The simplest member of these higher-order classes are.

Researchers, however, have not yet observed such a quadrupole moment in a solid. But they demonstrated the existence of a new form of electronic matter for which that property is possible: a quadrupole topological insulator.

A single circuit board, foreground, that when joined with others forms the experimental array of the quadrupole topological insulator. Credit: L. Brian Stauffer

Researchers have produced a "human scale" demonstration of a new phase of matter called quadrupole topological insulators that was recently predicted using theoretical physics. These are the first experimental findings to validate this theory.
UNH researchers find space radiation is increasingly more hazardous

It might sound like something from a science fiction plot - astronauts traveling into deep space being bombarded by cosmic rays - but radiation exposure is science fact. As future missions look to travel back to the moon or even to Mars, new research from the University of New Hampshire’s Space Science Center cautions that the exposure to radiation is much higher than previously thought and could have serious implications on both astronauts and satellite technology.

“The radiation dose rates from measurements obtained over the last four years exceeded trends from previous solar cycles by at least 30 percent, showing that the radiation environment is getting far more intense,” said Nathan Schwadron, professor of physics and lead author of the study.

“These particle radiation conditions present important environmental factors for space travel and space weather, and must be carefully studied and accounted for in the planning and design of future missions to the moon, Mars, asteroids and beyond.”

In their study, recently published in the journal Space Weather, the researchers found that large fluxes in Galactic Cosmic Rays (GCR) are rising faster and are on path to exceed any other recorded time in the space age.

They also point out that one of the most significant Solar Energetic Particle (SEP) events happened in September 2017 releasing large doses of radiation that could pose significant risk to both humans and satellites.

Unshielded astronauts could experience acute effects like radiation sickness or more serious long-term health issues like cancer and organ damage, including to the heart, brain, and central nervous system.

In 2014, Schwadron and his team predicted around a 20 percent increase in radiation dose rates from one solar minimum to the next. Four years later, their newest research shows current conditions exceed their predictions by about 10 percent, showing the radiation...Read More...

‘Red and dead’ NGC 1277 offers insights on the early universe

New analysis of a “relic galaxy” promises insights into the nature of the early universe.

Formed some 12 billion years ago, the NGC 1277 galaxy birthed all of its stars within a span of 100 million years -- a star formation rate 1,000 times greater than that of the Milky Way. But nearly as quickly as the galaxy sprang to life, it died out.

For the last 10 billion years, NGC 1277 has remained unchanged -- a relic of an earlier time in galactic evolution. To better understand the dynamics of the early universe, scientists used the Hubble Space Telescope to study NGC 1277.

The lenticular galaxy is what’s known as a “red and dead” galaxy. Most dead and red galaxies are found in the distant universe, too far away to be imaged in great detail. But at 240 million light-years away from Earth, NGC 1277 is close enough to offer insights.

Most galaxies feature both red globular clusters, full of metal-rich stars, and blue clusters, globs of metal-poor stars.

Models of galactic evolution suggest red clusters form during the earliest stages of a galaxy’s formation, with blue clusters acquired later as new star forming material is pulled from the galaxy’s surroundings. The lack of blue globular clusters is a sign that a galaxy stopped evolving -- that it is in a “state of arrested development.”

Red and dead galaxies host mostly red clusters. NGC 1277 has only red clusters.

“I’ve been studying globular clusters in galaxies for a long time, and this is the first time I’ve ever seen this,” Michael Beasley, a researcher with the Astrophysics Institute of the Canary Islands, said in a news release.

Scientists believe the massive black hole at the center of NGC 1277 grew quickly, pulling in stellar materials at a prodigious rate, inspiring the formation of the galaxy. But it’s development stopped suddenly when it ran out of stellar material. As a result, the galaxy hosts...Read More...
Scientists help solve mystery of why comets emit X-rays

Credit: CC0 Public Domain

The mystery of why comets travelling through Space give off X-ray emissions has been solved thanks to new research undertaken by a team that included science staff from STFC’s Central Laser Facility (CLF) and RAL Space.

Scientists have long wondered why comets can radiate X-rays, given that X-rays are normally associated with hot objects like the Sun but comets are among the coldest objects in the Solar system.

When comets travel through the Solar system they interact with the Solar radiation, the Solar wind and the Solar magnetic field. This interaction produces a visible atmosphere or coma around the comet and the observed cometary tail, and in some cases produces X-rays. These X-rays are generated on the Sunward side of the comet where the Solar wind impacts the cometary atmosphere forming a bow shock.

To investigate how X-rays can be emitted from a comet, a team of scientists from 15 research institutes performed experiments at the LULI laser facility in Paris where they replicated the interaction of the Solar wind with a comet.

The STFC team involved in the project were instrumental in coming up with the scientific model for the interaction of the Solar wind with the comet. This included the theoretical model for the generation of plasma turbulence, the acceleration of electrons by the turbulence and the X-ray emission from the accelerated electrons. The STFC team also supported a team from the University of Oxford in numerical simulations and undertook the target fabrication.

CLF’s Professor Bob Bingham led the STFC team involved in the project and said...

Laser-heated nanowires produce micro-scale nuclear fusion with record efficiency

The target chamber (front) and ultra-high intensity laser (back) used in the micro-scale fusion experiment at Colorado State University. Credit: Advanced Beam Laboratory/Colorado State University

Nuclear fusion, the process that powers our sun, happens when nuclear reactions between light elements produce heavier ones. It’s also happening—at a smaller scale—in a Colorado State University laboratory.

Using a compact but powerful laser to heat arrays of ordered nanowires, CSU scientists and collaborators have demonstrated micro-scale nuclear fusion in the lab. They have achieved record-setting efficiency for the generation of neutrons—chargeless sub-atomic particles resulting from the fusion process. Their work is detailed in a paper published in Nature Communications, and is led by Jorge Rocca, University Distinguished Professor in electrical and computer engineering and physics. The paper’s first author is Alden Curtis, a CSU graduate student.

Laser-driven controlled fusion experiments are typically done at multi-hundred-million-dollar lasers housed in stadium-sized buildings. Such experiments are usually geared toward harnessing fusion for clean energy applications.

In contrast, Rocca’s team of students, research scientists and collaborators, work with an ultra-fast, high-powered tabletop laser they built from scratch. They use their fast, pulsed laser to irradiate a target of invisible wires and instantly create extremely hot, dense plasmas—with conditions approaching those inside the sun. These plasmas drive fusion reactions, giving off helium and flashes of energetic neutrons.

In their Nature Communications experiment, the team produced a record number of neutrons per unit of laser energy—about 500 times better than experiments that use conventional flat targets from the same material. Their laser’s target was an array of nanowires made out of a material called deuterated polyethylene. The material is similar to the widely used polyethylene plastic, but its common hydrogen atoms are substituted by deuterium, a heavier kind of hydrogen atom...

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NASA Dawn Reveals Recent Changes in Ceres’ Surface

This view from NASA’s Dawn mission shows where ice has been detected in the northern wall of Ceres’ Juling Crater, which is in almost permanent shadow. Dawn acquired the picture with its framing camera on Aug. 30, 2016, and it was processed with the help of NASA Ames Stereo Pipeline (ASP), to estimate the slope of the cliff.

Observations of Ceres have detected recent variations in its surface, revealing that the only dwarf planet in the inner solar system is a dynamic body that continues to evolve and change.

NASA’s Dawn mission has found recently exposed deposits that give us new information on the materials in the crust and how they are changing, according to two papers published March 14 in Science Advances that document the new findings.

Observations obtained by the visible and infrared mapping spectrometer (VIR) on the Dawn spacecraft previously found water ice in a dozen sites on Ceres. The new study revealed the abundance of ice on the northern wall of Juling Crater, a crater 12 miles (20 kilometers) in diameter. The new observations, conducted from April through October 2016, show an increase in the amount of ice on the crater wall.

“This is the first direct detection of change on the surface of Ceres,” said Andrea Raponi of the Institute of Astrophysics and Planetary Science in Rome.

Raponi led the new study, which found changes in the amount of ice exposed on the dwarf planet. “The combination of Ceres moving closer to the sun in its orbit, along with seasonal change, triggers the release of water vapor from the subsurface, which then condenses on the cold crater wall. This causes an increase in the amount of exposed ice. The warming might also cause landslides on the crater walls that expose fresh ice patches.”

By combining chemical, geological and geophysical observations, the Dawn mission is producing a comprehensive view of Ceres. Previous data had shown Ceres has a crust about 25 miles (40 kilometers) thick and rich in water, salts and, possibly, organics. [Read More...]

Astronomers discover galaxies spin like clockwork

This Hubble image reveals the gigantic Pinwheel galaxy, one of the best known examples of “grand design spirals”, and its supergiant star-forming regions in unprecedented detail. The image is the largest and most detailed photo of a spiral galaxy ever released from Hubble.

Astronomers have discovered that all galaxies rotate once every billion years, no matter how big they are.

The Earth spinning around on its axis once gives us the length of a day, and a complete orbit of the Earth around the Sun gives us a year.

“It’s not Swiss watch precision,” said Professor Gerhardt Meurer from the UWA node of the International Centre for Radio Astronomy Research (ICRAR).

“But regardless of whether a galaxy is very big or very small, if you could sit on the extreme edge of its disk as it spins, it would take you about a billion years to go all the way round.”

Professor Meurer said that by using simple maths, you can show all galaxies of the same size have the same average interior density.

“Discovering such regularity in galaxies really helps us to better understand the mechanics that make them tick - you won’t find a dense galaxy rotating quickly, while another with the same size but lower density is rotating more slowly,” he said.

Professor Meurer and his team also found evidence of older stars existing out to the edge of galaxies.

“Based on existing models, we expected to find a thin population of young stars at the very edge of the galactic disks we studied;” he said.

“But instead of finding just gas and newly formed stars at the edges of their disks, we also found a significant population of older stars along with the thin smattering of young stars and interstellar gas.”

“This is an important result because knowing where a galaxy ends means we astronomers can limit our observations and not waste time, effort and computer processing power on studying data from beyond that.” [Read More...]

...Read More...
Scientists create diodes made of light

Credit: National Physical Laboratory

Photonics researchers at the National Physical Laboratory (NPL) have achieved the extra-ordinary by creating a diode consisting of light that can be used, for the first time, in miniaturised photonic circuits, as published in Optica.

Dr. Pascal Del’Haye and his team at NPL have created an optical version of a diode that transmits light in one direction only, and can be integrated in microphotonic circuits. This small-scale integration has been a major challenge in photonics because existing optical diodes require bulky magnets.

NPL’s ground-breaking work has overcome the limitation of diodes based on bulky magnets, by using light stored in tiny chip-based glass rings to form a diode.

Diodes are well known in electronic circuits. They transmit electric current in one direction but block the current in the backward direction. Diodes are essential components of nearly every electronic circuit and are used, for example, in battery chargers.

The novel technique was created by sending lots of light into a microresonator - a glass ring on a silicon chip, about the width of a human hair – and harnessing the circulating optical power to generate the diode effect.

Dr. Jonathan Silver, Higher Research Scientist at NPL, explains: “To create the optical diodes we used microrings that can store extremely large amounts of light. This meant that, even though we were only sending small amounts of light into these glass rings, the circulating power was comparable to the light generated by the flood lights in a whole football stadium—but confined into a device smaller than a human hair. The light intensities enable the formation of a diode via a light-with-light interaction called the Kerr effect.”

In their experiments, they have shown that the electromagnetic field of clockwise circulating light in these glass rings effectively blocks any counterclockwise circulating light.

Pascal Del’Haye, Principal Research Scientist of the project emphasises: “These diodes will, for the first time, open the door to cheap and efficient optical diodes. ...Read More...

Brightest fast radio burst yet recorded at Parkes in Australia

Credit: Daniel John Reardon/CC BY-SA 4.0

A team of researchers at the Parkes Observatory in NSW Australia has reported recording the brightest fast radio burst (FRB) yet on March 9 of this year. They describe it as having a high signal-to-noise ratio with an “orientation not very favorable for a detection of any gamma ray transient with INTEGRAL all-sky detectors.

FRBs are millisecond bursts of radio waves that originate from unknown parts of space. The first known recorded event occurred in 2001, but it was not until 2007 that researchers noticed and verified it. Since that time, 32 more have been recorded, and all, save one, were one-time occurrences—the lone exception was found to repeat, and because of that, researchers were able to trace it back to an originating galaxy. The rest, unfortunately, remain a mystery, though most in the field suspect they are generated by cataclysmic events involving black holes or neutron stars.

The record-breaking FRB came during a brief period in which three were recorded—all by the team at Parks—an earlier one occurred on March 1 and a later one on March 11. The team describes recording three FRBs in one month as “quite unusual,” because they are normally very difficult to record due to their unpredictability—no one knows when or in which part of the sky one will occur. But that might change, as experts have suggested that FRBs likely occur every day, but are unnoticed because we do not have a telescope pointing at the target.

Because of the limited number of recordings, space researchers know very little about them, though clues suggest some insight into their origin. For one thing, they all have a sweep in frequency, which suggests that they come from very far away—many billions of light years. That we are able to detect them after they traveled so far also reveals something else—the source must be incredibly bright, which hints at neutron stars or black holes experiencing some truly huge events.

Most in the field expect many more sightings in the coming years as more teams try in earnest to record them. There is also optimism regarding their nature. ...Read More...
Stephen Hawking had pinned his hopes on ‘M-theory’ to fully explain the universe—here’s what it is

Are there other universes? Credit: Pixabay., CC BY

Rumour has it that Albert Einstein spent his last few hours on Earth scribbling something on a piece of paper in a last attempt to formulate a theory of everything. Some 60 years later, another legendary figure in theoretical physics, Stephen Hawking, may have passed away with similar thoughts. We know Hawking thought something called “M-theory” is our best bet for a complete theory of the universe. But what is it?

Since the formulation of Einstein’s theory of general relativity in 1915, every theoretical physicist has been dreaming of reconciling our understanding of the infinitely small world of atoms and particles with that of the infinitely large scale of the cosmos. While the latter is effectively described by Einstein’s equations, the former is predicted with extraordinary accuracy by the so-called Standard Model of fundamental interactions.

Our current understanding is that the interaction between physical objects is described by four fundamental forces. Two of them – gravity and electromagnetism – are relevant for us on a macroscopic level, we deal with them in our everyday life. The other two, dubbed strong and weak interactions, act on a very small scale and become relevant only when dealing with subatomic processes.

The standard model of fundamental interactions provides a unified framework for three of these forces, but gravity cannot be consistently included in this picture. Despite its accurate description of large scale phenomena such as a planet’s orbit or galaxy dynamics, general relativity breaks down at very short distances. According to the standard model, all forces are mediated by specific particles. For gravity, a particle called the graviton does the job. But when trying to calculate how these gravitons interact, nonsensical infinities appear.

A consistent theory of gravity should be valid at any scale and should take into account the quantum nature of fundamental particles. This would accommodate...Read More...

Mystery of purple lights in sky solved with help from citizen scientists

STEVE and the Milky Way at Childs Lake, Manitoba, Canada. The picture is a composite of 11 images stitched together. Credit: Krista Trinder

Notanee Bourassa knew that what he was seeing in the night sky was not normal. Bourassa, an IT technician in Regina, Canada, trekked outside of his home on July 25, 2016, around midnight with his two younger children to show them a beautiful moving light display in the sky—an aurora borealis. He often sky gazes until the early hours of the morning to photograph the aurora with his Nikon camera, but this was his first expedition with his children. When a thin purple ribbon of light appeared and starting glowing, Bourassa immediately snapped pictures until the light particles disappeared 20 minutes later. Having watched the northern lights for almost 30 years since he was a teenager, he knew this wasn’t an aurora. It was something else.

From 2015 to 2016, citizen scientists—people like Bourassa who are excited about a science field but don’t necessarily have a formal educational background—shared 30 reports of these mysterious lights in online forums and with a team of scientists that run a project called Aurorasaurus. The citizen science project, funded by NASA and the National Science Foundation, tracks the aurora borealis through user-submitted reports and tweets.

The Aurorasaurus team, led by Liz MacDonald, a space scientist at NASA’s Goddard Space Flight Center in Greenbelt, Maryland, conferred to determine the identity of this mysterious phenomenon. MacDonald and her colleague Eric Donovan at the University of Calgary in Canada talked with the main contributors of these images, amateur photographers in a Facebook group called Alberta Aurora Chasers, which included Bourassa and lead administrator Chris Ratzlaff. Ratzlaff gave the phenomenon a fun, new name, Steve, and it stuck.

But people still didn’t know what it was.

Scientists’ understanding of Steve changed that night Bourassa snapped his pictures. Bourassa...Read More...
Special Read:

**Changed Man With ‘Space Genes’: Alterations in US Astronaut’s Body Startled NASA**

Mark and Scott Kelly.

After a year in space International Space Station (ISS) astronaut Scott Kelly returned home slimmer, taller and with younger cells. However, some changes were not for the better.

NASA researchers have revealed preliminary results of the Twins Study project, which took a closer look at individual health and alterations, caused by space travel.

The scientists studied the only identical twin astronauts in history, Scott and Mark Kelly, whose genetic codes became significantly different after Scott had spent 340 days aboard the ISS, while his brother stayed on Earth.

The mission is a stepping stone to a three-year journey to Mars.

NASA suggest a year-long journey may have activated the so-called “space genes,” while others could have been switched off due to different types of stress. A year-long mission, significantly longer than standard six-month journeys, caused physical (low-gravity and low-oxygen environment) and mental stress.

“Such actions can trigger the assembly of new molecules, like a fat or protein, cellular degradation, and can turn genes on and off, which change cellular function,” stated the agency.

The project group studied the brothers’ levels of physical and mental stress before, during and after Scott’s journey, charting the slightest changes.

Some physical alteration, e.g. 2-inch difference in height, as well as most of genetic changes reversed after some time on Earth. However, seven percent of the astronaut’s DNA seems to have changed permanently.

These changes concern bone formation, oxygen deprivation, immune system responses and DNA repair after the space stress, most people don’t experience naturally. For instance telomeres, which protect our chromosomes from dysfunctions, became longer, which is a sign of younger cells. At the same time his microflora changed, which led to more inflammations, while the bones became weaker.

“The body thinks there’s a reason to defend itself. We know there are aspects of being in space that are not a pleasant experience, and this is the molecular manifestation of the body responding to that stress;” Twins Study researcher Christopher Mason told Business Insider.

The Twins Study was the first study of its kind. The project involved 10 individual investigations, 12 universities, NASA biomedical laboratories and National Space Biomedical Research Institute - with over 200 researchers...
### This Week’s Sky at a Glance
**Mar. 17-23, 2018**

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