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Astronomy & Physics News

Department of Physics—United Arab Emirates University
Weekly news from around the world compiled by Dr. Ilias Fernini

100 Million Stars in the Andromeda galaxy.

Inside this issue:

Scientists predict earth-like planets around most stars

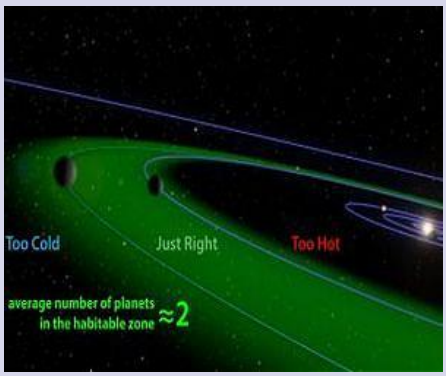
Planetary scientists have calculated that there are hundreds of billions of Earth-like planets in our galaxy which might support life.

The new research, led by PhD student Tim Bovaird and Associate Professor Charley Lineweaver from The Australian National University (ANU), made the finding by applying a 200 year old idea to the thousands of exo-planets discovered by the Kepler space telescope.

They found the standard star has about two planets in the so-called goldilocks zone, the distance from the star where liquid water, crucial for life, can exist.

"The ingredients for life are plentiful, and we now know that habitable environments are plentiful," said Associate Professor Lineweaver, from the ANU Research School of Astronomy and Astrophysics and the Research School of Earth Sciences.

"However, the universe is not teeming with aliens with human-like intelligence that can build radio telescopes and space ships. Otherwise we would have seen or heard from them...***Read More***...

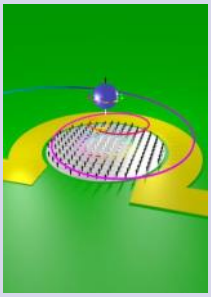


This is the Goldilocks zone, where liquid water can exist. Image courtesy Aditya Chopra, ANU, adapted from NASA/JPL.

Dance of the nanovortices

It is a familiar phenomenon: if a spinning top is bumped or is set in rotation on an inclined surface, it usually does not move in a straight line, but instead scribes a series of small arches. Researchers at Technische Universität Berlin and the Johannes Gutenberg University Mainz (JGU) together with research teams from the Netherlands and Switzerland have now succeeded in capturing and recording this pattern of movement in a magnetic thin film system – in the form of small magnetic nanovortices. In doing so, the researchers made a new discovery: the nanovortices possess mass. The article will be published in the renowned scientific journal Nature Physics.

"With the help of magnetic fields, we can selectively create the magnetic nanovortices, then give them a shove so that they are deflected out of their equilibrium position", explains Dr. Felix Büttner, who pursued this research as his Ph.D. project. "We were then able to very precisely track how these skyrmions, as these special nanovortices are called, return to their rest position", Büttner explains further. The vortices are formed in a magnetic system of thin film multilayers, where alternating layers composed of a cobalt-boron alloy and platinum are stacked on one another. Each individual layer is less than one nanometre thick...***Read More***...



The local magnetisation is depicted by small arrows; a magnetic vortex is located in the centre. A brief current pulse through this nano-wire deflects the skyrmion out of its rest position; it then moves back to its initial position on a spiral trajectory. This motion can be observed with the help of X-ray holography. The skyrmion and the spiral shape of its trajectory are represented schematically above the structure. Credit: TU Berlin

Hubble Captures Rare Triple-Moon Conjunction

Firing off a string of action snapshots like a sports photographer at a NASCAR race, NASA's Hubble Space Telescope captured the rare occurrence of three of Jupiter's largest moons racing across the banded face of the gas-giant planet: Europa, Callisto, and Io.

These so-called Galilean moons, named after the 17th century scientist Galileo Galilei, who discovered them with a telescope, complete orbits around Jupiter with durations ranging from 2 days to 17 days. They can commonly be seen transiting the face of Jupiter and casting shadows onto its cloud tops. However, seeing three moons transiting the face of Jupiter at the same time is rare, occurring only once or twice a decade.

The Hubble image on the left shows the beginning of the event, which took place on January 24, 2015. From left to right, the moons Callisto and Io are above Jupiter's cloud tops. The shadows from Europa, Callisto, and Io are strung out from left to right. Europa is not visible in this image.

Near the end of the event, approximately 42 minutes later (right-side image) Europa has entered the frame at lower left. Slower-moving Callisto is above and to the right of Europa. Fastest-moving Io is approaching the eastern limb of the planet; its shadow is no longer visible on Jupiter. Europa's shadow is toward the left side of the image, and Callisto's shadow to the right. The moons' orbital velocities are proportionally slower with increasing distance from the planet….***Read More***...

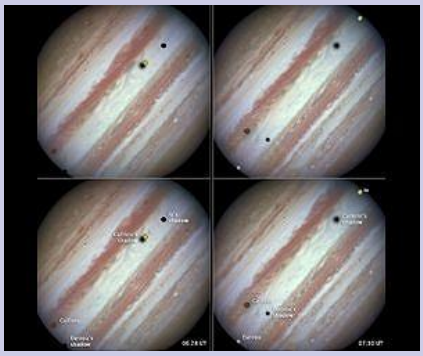


Image courtesy NASA, ESA, and the Hubble Heritage Team (STScI/AURA).

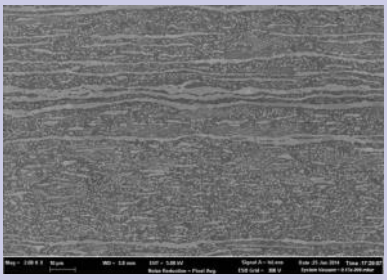
New process allows for stronger, lighter, flexible steel

A trio of researchers with South Korea's Graduate Institute of Ferrous Technology has found a way to create a new low-density steel that is stronger, lighter and more flexible than the conventional steel that is used in so many manufacturing applications. In their paper published in the journal Nature, the team describes the process they used and their hopes that it might replace conventional steel in some applications sometime in the near future.

One of the biggest applications for steel is, of course in making cars, though its dominance has been slipping in recent years as engineers seek to find lighter substitutes. At issue is weight, steel is heavy because it is made mostly out of iron.

Adding other lighter metals tends to make it less flexible or weaker. In this new effort, the researchers report that they have found a mix that allows for creating a low-density steel that is stronger and more flexible than much more expensive titanium alloys.

The secret, the team explains, lies in causing new structure shapes to be formed during the heating process and by using the right mix of ingredients. They used the traditional mix of iron, carbon, aluminum and manganese and then added some nickel. The nickel, they found reacted with the aluminum, creating nanometer sized B2 crystals that formed within and between the steel grains during the annealing process. To make sure the crystals were spread evenly among the metal, the team studied samples under an electron ...***Read More***...



Annealed microstructure of high-specific-strength steel (HSSS). Fine FeAl-type B2 precipitates form during annealing in between the B2 stringer bands in steel matrix. The specimen was annealed for 15 min at 900C. Credit: Hansoo Kim

The power of light-matter coupling

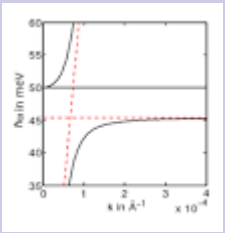
A theoretical study shows that strong ties between light and organic matter at the nanoscale open the door to modifying these coupled systems' optical, electronic or chemical properties.

Light and matter can be so strongly linked that their characteristics become indistinguishable. These light-matter couplings are referred to as polaritons. Their energy oscillates continuously between both systems, giving rise to attractive new physical phenomena. Now, scientists in France have explained why such polaritons can remain for an unusual long time at the lowest energy levels, in such a way that alters the microscopic and macroscopic characteristics of their constituting matter.

These findings thus pave the way for optical, electronic and chemical applications. The work has been published in EPJ D by Antoine Canaguier-Durand from the University of Strasbourg, France, and colleagues.

The authors elected to study polaritons made of organic molecules that are strongly coupled with a small number of photons. They examined polariton relaxation dynamics, which occur when polaritons transition from high energy to lower energy levels. To do so, the team employed a rigorous mathematical approach called "dressed atoms", which makes it possible to deduce characteristics such as transition rates from high to lower energy levels, for example.

In this study, the authors explain why the lifetime of the lowest lying polariton energy state is ...***Read More***...



Dispersion relation of polaritons in GaP. Red curves are the uncoupled phonon and photon dispersion relations, black curves are the result of coupling (from top to bottom: upper polariton, LO phonon, lower polariton). ..Wikipedia.

How would the world change if we found extraterrestrial life?

In 1938, Orson Welles narrated a radio broadcast of "War of the Worlds" as a series of simulated radio bulletins of what was happening in real time as Martians arrived on our home planet. The broadcast is widely remembered for creating public panic, although to what extent is hotly debated today.

Still, the incident serves as an illustration of what could happen when the first life beyond Earth is discovered. While scientists might be excited by the prospect, introducing the public, politicians and interest groups to the idea could take some time.

How extraterrestrial life would change our world view is a research interest of Steven Dick, who just completed a term as the Baruch S. Blumberg NASA/Library of Congress Chair of Astrobiology. The chair is jointly sponsored by the NASA Astrobiology Program and the John W. Kluge Center, at the Library of Congress.

Dick is a former astronomer and historian at the United States Naval Observatory, a past chief historian for NASA, and has published several books concerning the discovery of life beyond Earth. To Dick, even the discovery of microbes would be a profound shift for science.

"If we found microbes, it would have an effect on science, especially biology, by universalizing biology," he said. "We only have one case of biology on Earth. It's all related. It's all DNA-based. If we found an independent example on Mars or Europa, we have a chance of forming a universal biology."

Dick points out that even the possibilities of extraterrestrial fossils could change our viewpoints, such as the ongoing discussion of ALH84001, a Martian meteorite found in Antarctica that erupted into public consciousness in 1996 after a Science article said structures inside of it could be linked to biological activity. The conclusion, which is still debated ...***Read More***….

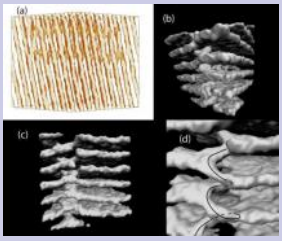
The ALH84001 meteorite, which in a 1996 Science publication was speculated to be host to what could be ancient Martian fossils. That finding is still under dispute today. Credit: NASA/JSC/Stanford University

Nuclear pasta may offer insight into strange world of neutron stars

Neutron stars, which form when massive stars collapse under their own enormous gravity, are some of the densest objects in the universe, second only to black holes. Yet while little is known about the interiors of black holes, scientists have a somewhat better understanding of what goes on inside neutron stars due to the fact that some of them emit radiation, often as X-rays. Using telescopes to detect this radiation, scientists know that the matter inside neutron stars is unlike anything found on Earth.

Neutron stars are made almost entirely of neutrons, and are held together so tightly that their density is about the same as that of an atomic nucleus. But because of the gigantic size difference (about 10 km in diameter for a neutron star and 10-15 m for an atomic nucleus), the similarities end there. While a nucleus is held together by the strong force, a neutron star is held together by its powerful gravitational force. Under the enormous pressure exerted by this gravity, large numbers of neutrons can form giant stable nuclei—nuclei so large that they would quickly decay on Earth.

While the largest of a neutron star's nuclei exist in its inner core, forming an exotic ultra-dense quark-gluon plasma, the star's less dense outer edges ...***Read More***...



Simulations reveal the existence of screw-like topological defects in "nuclear pasta"—matter that lies at the crust of neutron stars and separates the outer, more conventional matter from the ultra-dense matter deeper inside the stars. Credit: C. J. Horowitz, et al. ©2015

Researchers use transmission electron microscope as a thermometer at nanoscale

A team of researchers with the University of California has found a way to use a transmission electron microscope (TEM) as a thermometer for measuring heat in micro-electric devices. In their paper published in the journal Science, the team describes how they discovered using a TEM on a tiny piece of metal could reveal its density change as electrons passed through. Christian Colliex with the L'Université de Paris, offers a Perspective piece on the work by the team in the same journal edition.

As microelectronics have grown smaller, it has become more difficult to take their temperature, a necessary part of transistor design—traditional methods such as contact thermometers or radiative measurements become les viable as they tend to add heat or offer poor resolution. That means that scientists have had to look for other ways to get the job done. In this new effort, the researchers went back to one of the original designs, the old-school mercury thermometer, for inspiration. Such old time thermometers were able to note temperature differences because the density of the mercury changed predictably as the temperature changed. The density of other metals change due to temperature differences as well, and that was the approach the team used to measure temperature changes in a very small metal wire.

When electricity is sent through a wire, it causes a density change in the wire due to charge vibrations, which can be seen using a TEM at nanometer scale. The researchers sent electricity through a tiny aluminum wire while simultaneously scanning it with a TEM—as the electrons .***Read More***...

This composite image shows density (grey) and temperature (color) maps of a 100 nm-wide polycrystalline aluminum wire. The temperature is computed from the density using aluminum's known thermal expansion. Lower densities appear at crystal-grain boundaries, which are atomic-scale features, and where thermal expansion has caused the aluminum to expand. One end of the wire (green) is near room temperature, and the other (orange) is 160 K warmer. Credit: USC CEMMA & UCLA Regan

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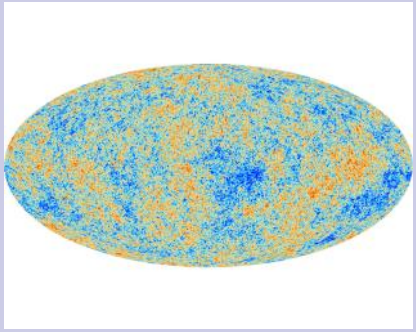
Cosmic inflation: Dust finally settles on BICEP2 results

Reports of evidence of cosmic inflation may have been, well, overblown.

When the BICEP2 team announced last year that they had found signs of cosmic inflation, the universe's powerful growth spurt that had been predicted but that had never been directly detected, it was seen as a potentially major breakthrough in cosmology. But now, a joint team that includes the BICEP2 researchers has found that there is no clear evidence of the primordial gravitational waves that signaled this enormous growth spurt, and that much of the signal was clearly caused by dust.

"I think the conclusion is that the BICEP2 team misinterpreted their results," said David Spergel, a Princeton University cosmologist who was not involved in the work and who wrote a paper last year arguing that the strange signal was due to dust. "They effectively with this paper have withdrawn their claim of detection."

The findings, submitted to the journal Physical Review Letters, leave the search for primordial gravitational waves wide open. "It leaves us on the journey. ...***Read More***...



The anisotropies of the Cosmic Microwave Background (CMB) as observed by Planck. The CMB is a snapshot of the oldest light in our Universe, imprinted on the sky when the Universe was just 380 000 years old. It shows tiny temperature fluctuations that correspond to regions of slightly different densities, representing the seeds of all future structure: the stars and galaxies of today. The highest resolution version of this image [12 572 px × 6286 px] is available upon request. Please make inquiries using the "Contact Us" link in the left-hand menu. Credit: ESA, Planck Collaboration

IYL 2015 Switches On in the City of Light

APS is a founding partner of the International Year of Light and Light-based Technologies (IYL 2015), a year-long, global outreach effort of more than 100 scientific societies to communicate the importance of light, optics, and photonics to the world. Along with the other U.S. founding partners, the Society is collaborating on light-themed events and programs throughout the year and beyond.

"The idea is to celebrate the scientific discoveries that have been made over the years in light," said Becky Thompson, head of outreach for APS. "We also want to ...***Read More***....

One of several IYL art installations featuring the use of light at UNESCO headquarters.