August 27, 2016 Dhu'l Qiddah 23, 1437 AH Volume 6, Issue 35

Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - **University of Sharjah**
Compiled by **Dr. Ilias Fernini**

مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

Top News

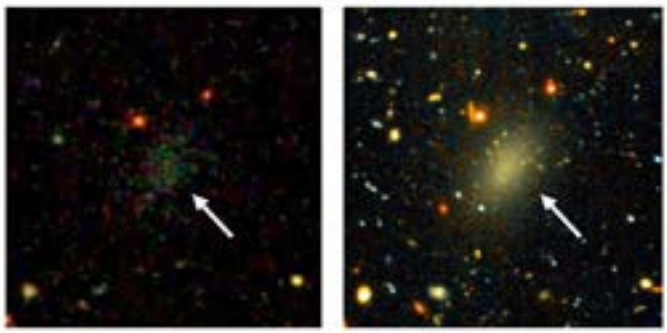
New Weekly Addition:
This Week's Sky at a Glance, Aug. 27- Sep. 02

جامعة الشارقة
UNIVERSITY OF SHARJAH

IT Support Issam Jami

Design by Mohamed Bakir

Scientists discover a 'dark' Milky Way: Massive galaxy consists almost entirely of dark matter



The dark galaxy Dragonfly 44. The image on the left is from the Sloan Digital Sky Survey. Only a faint smudge is visible. The image on the right is a long exposure with the Gemini telescope, revealing a large, elongated object. Dragonfly 44 is very faint for its mass and consists almost entirely of dark matter. Credit: Pieter van Dokkum, Roberto Abraham, Gemini, Sloan Digital Sky Survey

Using the world's most powerful telescopes, an international team of astronomers has found a massive galaxy that consists almost entirely of dark matter.

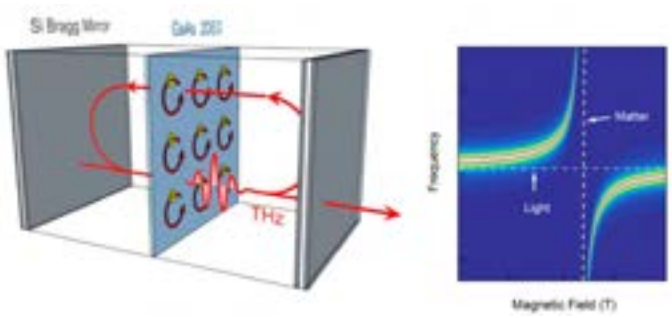
The galaxy, Dragonfly 44, is located in the nearby Coma constellation and had been overlooked until last year because of its unusual composition: It is a diffuse "blob" about the size of the Milky Way, but with far fewer stars. "Very soon after its discovery, we realized this galaxy had to be more than meets the eye. It has so few stars that it would quickly be ripped apart unless something was holding it together," said Yale University astronomer Pieter van Dokkum, lead author of a paper in the Astrophysical Journal Letters.

Van Dokkum's team was able to get a good look at Dragonfly 44 thanks to the W.M. Keck Observatory and the Gemini North telescope, both in Hawaii. Astronomers used observations from Keck, taken over six nights, to measure the velocities of stars in the galaxy. They used the 8-meter Gemini North telescope to reveal a halo of spherical clusters of stars around the galaxy's core, similar to the halo that surrounds our Milky Way galaxy.

Star velocities are an indication of the galaxy's mass, the researchers noted. The faster the stars move, the more mass its galaxy will have.

"Amazingly, the stars move at velocities that are far greater than expected for such a dim galaxy. It means that Dragonfly 44 has a huge amount of ...Read More...

Light and matter merge in quantum coupling



A method created at Rice University closes the gap between light and matter and may help advance technologies like quantum computers and communications. The lab designed and built a high-quality cavity to contain an ultrathin layer of gallium arsenide. By tuning the material with a magnetic field to resonate with a certain state of light in the cavity, they prompted the formation of polaritons that act in a collective manner. Credit: Qi Zhang/Rice University

Where light and matter intersect, the world illuminates. Where light and matter interact so strongly that they become one, they illuminate a world of new physics, according to Rice University scientists.

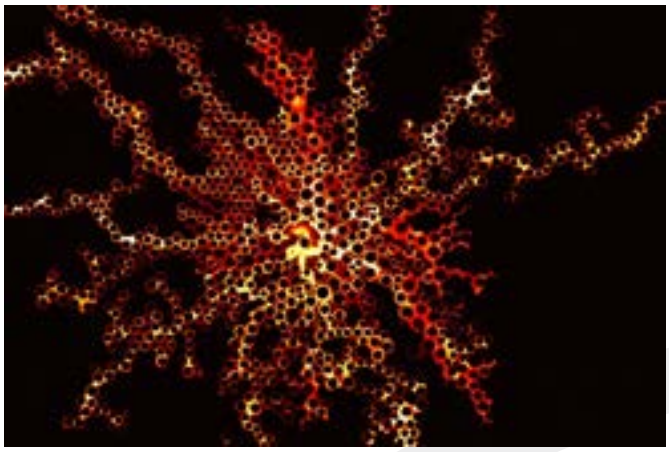
Rice physicists are closing in on a way to create a new condensed matter state in which all the electrons in a material act as one by manipulating them with light and a magnetic field. The effect made possible by a custom-built, finely tuned cavity for terahertz radiation shows one of the strongest light-matter coupling phenomena ever observed.

The work by Rice physicist Junichiro Kono and his colleagues is described in Nature Physics. It could help advance technologies like quantum computers and communications by revealing new phenomena to those who study cavity quantum electrodynamics and condensed matter physics, Kono said.

Condensed matter in the general sense is anything solid or liquid, but condensed matter physicists study forms that are much more esoteric, like Bose-Einstein condensates. A Rice team was one of the first to make a Bose-Einstein condensate in 1995 when it prompted atoms to form a gas at ultracold temperatures in which all the atoms lose their individual identities and behave as a single unit.

The Kono team is working toward something similar, but with electrons that are strongly coupled, or "dressed," with light. Qi Zhang, a former graduate student in Kono's group and lead author of the paper, designed and constructed an extremely high-quality cavity to contain an ultrathin layer of gallium arsenide, a material they've used to study superfluorescence. By tuning the material with a magnetic field to resonate with a certain state of ...Read More...

Study reveals new physics of how fluids flow in porous media



Lab simulations carried out by an MIT and Oxford University team provide detailed information about how a liquid moves through spaces in a porous material, revealing the key role of a characteristic called wettability. Credit: Massachusetts Institute of Technology

One of the most promising approaches to curbing the flow of human-made greenhouse gases into the atmosphere is to capture these gases at major sources, such as fossil-fuel-burning power plants, and then inject them into deep, water-saturated rocks where they can remain stably trapped for centuries or millennia.

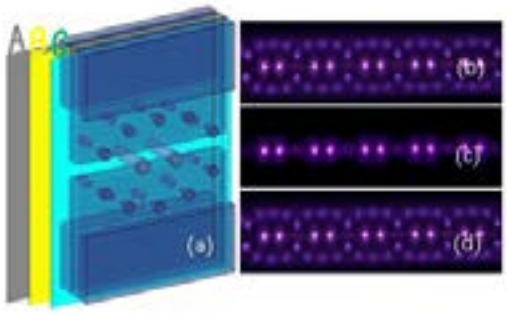
This is just one example of fluid-fluid displacement in a porous material, which also applies to a wide variety of natural and industrial processes—for example, when rainwater penetrates into soil by displacing air, or when oil recovery is enhanced by displacing the oil with injected water.

Now, a new set of detailed lab experiments has provided fresh insight into the physics of this phenomenon, under an unprecedented range of conditions. These results should help researchers understand what happens when carbon dioxide flows through deep saltwater reservoirs, and could shed light on similar interactions such as those inside fuel cells being used to produce electricity without burning hydrocarbons.

The new findings are being published this week in the journal PNAS, in a paper by Ruben Juanes, MIT's ARCO Associate Professor in Energy Studies; Benzhong Zhao, an MIT graduate student; and Chris MacMinn, an associate professor at Oxford University.
A crucial aspect of fluid-fluid displacement is the displacement efficiency, which measures how much of the pre-existing fluid can be pushed out of the pore space. High displacement efficiency means that most of the pre-existing fluid is pushed out, which is usually a good thing—with oil recovery, for example, it means that more oil would be captured and less would be left behind. Unfortunately, displacement efficiency has been very difficult to predict.

A key factor in determining displacement efficiency, Juanes says, is a characteristic called wettability. Wettability is a material property that measures a preference by the solid to be in contact with one of the fluids more than the other. The team found that the stronger the preference for the injected fluid, the more effective the displacement of the pre-existing fluid ...Read More...

Understanding nature's patterns with plasmas



A schematic diagram of the spatial distributions of the pattern in three cross sections A, B and C along z axis. (a) A sketch of three dimenstional pattern. (b-d) Schematic diagram of the spatial distributions of the pattern in cross section A, B and C denoted in (a). Credit: Hebei University

Patterns abound in nature, from zebra stripes and leopard spots to honeycombs and bands of clouds. Somehow, these patterns form and organize all by themselves. To better understand how, researchers have now created a new device that may allow scientists to study patterns in 3-D like never before.

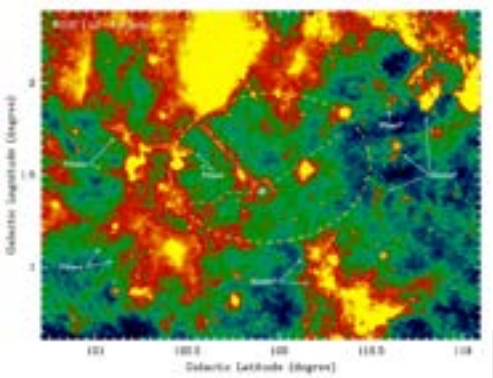
The specially designed system, called an H-shaped dielectric barrier discharge system, produces filaments of discharge plasma that can assume a vast range of patterns—in 3-D. By studying and mathematically modeling such patterns, researchers can explore what complex mechanisms may be producing nature's diverse designs.
"Setting up a dielectric barrier discharge system for 3-D patterns should greatly advance the science of pattern formation," said Lifang Dong, a professor at Hebei University in China.

More than 60 years ago, Alan Turing proposed a simple mathematical model called the reaction-diffusion model that corresponds to the change in space and time of the concentration of one or more chemical substances to explain nature's patterns. The model suggests that as two interacting chemicals spread out, they could arrange themselves as stripes, spots or other designs. Scientists have since used this reaction-diffusion model to explain a number of patterns like leopard spots, the location of feather buds in chicks, hair follicles in mice, and even the ridges on the roof of mouse embryo mouths.

One major limitation, though, is that most of these studies were confined to one- or two-dimensional experiments. At the molecular level, nature's patterns are three-dimensional.

But it's not easy to make 3-D patterns, Dong said. The first 3-D experiment didn't come until 2011, when researchers at Brandeis University used chemical ...Read More...

Astronomers discover a large cavity around the Tycho's supernova



The large-field WISE [12-4.6] μm infrared image around the Tycho's supernova remnant (SNR). The red circle shows the position and size of the shell-like structure in the Tycho's SNR, while the yellow dashed ellipse shows the cavity found in the MWISP CO images. The three white dashed lines are shown to guide the eye for the stream-like structures seen in the CO images. The white arrows mark the positions of the pillar-like structures found in the WISE image. Credit: Chen et al., 2016.

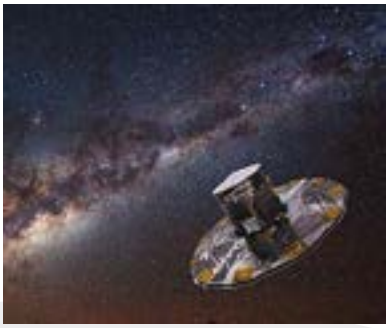
Chinese astronomers have detected a large cavity existing around Tycho's supernova, also know as SN 1572, exhibiting stream-like structures. The findings, reported in a paper published Aug. 18 on arXiv.org, show that the environments of the supernovae may be much more complicated than previously thought.

SN 1572 lies between 8,000 to 10,000 light years from the Earth in the constellation Cassiopeia. It is a well-established type Ia supernova, one of about eight supernovae visible to the naked eye in historical records. As one of the most popular supernova remnants in our galaxy, it has been widely observed in the entire electromagnetic spectrum, and astronomers have discovered a shell-like structure produced by the shocks from the explosion as well as circumstellar material and dust.

More recent observations of Tycho's supernova were conducted by a team of Chinese astronomers led by Xuepeng Chen of the Purple Mountain Observatory (PMO) in Nanjing, China. They used the 13.7-meter millimeter-wavelength telescope of the Qinghai station of PMO at Delingha in China to perform large-field and high-sensitivity carbon monoxide (CO) molecular line observations of SN 1572. The scientists observed the supernova from November 2011 to February 2016 as part of the Milky Way Imaging Scroll Painting (MWISP) survey, which investigates the nature of the molecular gas along the northern Galactic Plane.

"We present large-field CO (1-0) molecular line observations toward the Tycho's supernova remnant, using the PMO 13.7-meter telescope. Based on the CO observations, we find a large cavity with radii of 0.3 ... Read More...

Gaia's second anniversary marked by successes and challenges



Located at the L2 Lagrange point, 1.5 million km from Earth, Gaia surveys the entire sky as it spins on its axis. By repeatedly measuring the positions of the stars with extraordinary accuracy, Gaia is providing a huge treasure trove of data that enables scientists to tease out their distances and motions through our Galaxy.

Operating in the depths of space, far beyond the Moon's orbit, ESA's Gaia spacecraft has now completed two years of a planned five-year survey of the sky. Despite a series of unexpected technical challenges, the mission is on track to complete the most detailed and complex mapping of the heavens ever undertaken.

Selected as one of the 'Cornerstone' missions of ESA's science programme, Gaia is designed to pinpoint the positions, distances, motions and other properties of more than a billion stars. Its three instruments collect astrometric, photometric and spectroscopic data on stars in the Milky Way galaxy, as well as more distant galaxies and quasars, and nearby, but faint Solar System objects.

Located at the L2 Lagrange point, 1.5 million km from Earth, Gaia surveys the entire sky as it spins on its axis. By repeatedly measuring the positions of the stars with extraordinary accuracy, Gaia is providing a huge treasure trove of data that enables scientists to tease out their distances and motions through our Galaxy.

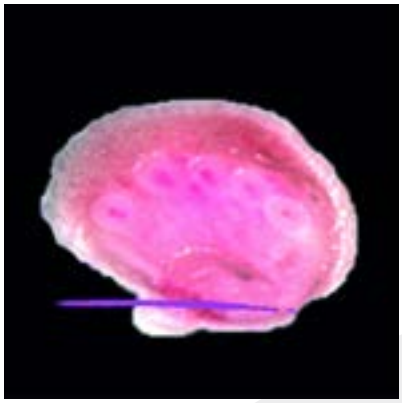
"More than 50 billion focal plane transits, 110 billion photometric observations and 9.4 billion spectroscopic observations have been successfully processed to date," notes Fred Jansen, ESA's mission manager for Gaia.

The immense volume of data and their complex nature have required a huge effort from the scientists and software developers, distributed across Europe, who make up Gaia's Data Processing and Analysis Consortium (DPAC). The first product of their efforts will be a public data release scheduled for 14 September.

"The spacecraft is working well and the data processing is on the right track," says Timo Prusti, ESA's project scientist for Gaia. "Most of the spacecraft systems that are crucial for the success of our mission have behaved as well as, or even better than, expected.

"These include the focal plane assembly, onboard data handling system, onboard detection of sources, the phased array antenna, and the attitude control and micro-propulsion subsystems."
. ..Read More...

Researchers make proton radiation in cancerous tissue visible using ultrasound technology



Ionoacoustics enables a precise real-time imaging of the position in tissue (pink) where the irradiation releases its biggest effect (displayed in purple). Credit: Stephan Kellnberger

Using ultrasound technology, physicists from the Munich-Centre for Advanced Photonics make proton radiation in cancerous tissue visible.

In future, the irradiation of tumors with protons could become more precise. Medical physicists from the Munich-Centre for Advanced Photonics (MAP) at the Ludwig-Maximilians-Universität (LMU), together with physicists from the Technical University (TUM), the Helmholtz Zentrum München (HMGU) and the Universität der Bundeswehr München (UniBWM) have combined conventional ultrasound technology with proton irradiation of a tumor. Using ionoacoustic technology they developed, they are able to observe the action of proton beams in real time via ultrasound.
A large number of tumors can be treated with radiation consisting of protons (positively charged hydrogen atoms), which attack and destroy the cancer cells of the tumor. However, it is crucial that the protons attack and kill only cancerous cells while sparing the surrounding healthy tissue. Doctors must therefore direct the energy of the protons precisely within the tumor in order to have maximum impact on the tumor cells.

In clinical applications, it is therefore important to know where the radiation from protons unleashes its maximum effect. In the human body, this is precisely where protons get stopped. This point of maximum dose delivery is known as the "Bragg peak" and should only occur within the tumor.

The medical physicists from the Munich-Centre for Advanced Photonics at LMU, in collaboration with research groups from TUM/HMGU and UniBWM, have now developed a method with which they can check where ion radiation deposits dose in a tumor during ...Read More...

History of the CubeSat

In some cases CubeSats may be used for low-cost scientific experiments that may verify underlying theories. In many cases, CubeSats represent a first national satellite for non-spacefaring nations. Finally, several future missions to the Moon and beyond are in the planning stages for CubeSats.

The "CubeSat" is a type of miniaturized satellite for low earth orbit (LEO) space research and applications. One of these is typically made up of one or more 10+ 10+ 11.35 cm cubic units, and each unit has a mass of no more than 1.33 kilograms. In addition to being light and small, designers often use commercial off-the-shelf (COTS) electronic and structural components.

Although bunches of CubeSats have been launched on dedicated rockets, they are most often put into orbit in small numbers via the International Space Station or placed in orbit as secondary payloads.

It all started about 17 years ago when California Polytechnic State University (Cal Poly) and Stanford University developed CubeSat specifications in order to promote and develop the skills necessary for creating small satellites intended for LEO operations.

Until 2013, university education and research activities accounted for the majority of CubeSat launches. Since then, over half of CubeSat launches have been for non-academic purposes. Today, most newly deployed CubeSats are used for commercial or amateur projects.

CubeSat applications usually involve experiments which can be miniaturized and provide services for Earth observation and amateur radio applications. Some CubeSats are used to demonstrate spacecraft technologies or as feasibility demonstrators that can help to justify the cost of a larger satellite.

In some cases CubeSats may be used for low-cost scientific experiments that may verify underlying theories. In many cases, CubeSats represent a first national satellite for non-spacefaring nations. Finally, several future missions to the Moon and beyond are in the planning stages for CubeSats. ...Read More...

Rocky planet found orbiting habitable zone of nearest star

This artist's impression shows a view of the surface of the planet Proxima b orbiting the red dwarf star Proxima Centauri, the closest star to the Solar System. The double star Alpha Centauri AB also appears in the image to the upper-right of Proxima itself. Proxima b is a little more massive than the Earth and orbits in the habitable zone around Proxima Centauri, where the temperature is suitable for liquid water to exist on its surface. Credit: ESO/M. Kornmesser.

An international team of astronomers including Carnegie's Paul Butler has found clear evidence of a planet orbiting Proxima Centauri, the closest star to our Solar System. The new world, designated Proxima b, orbits its cool red parent star every 11 days and has a temperature suitable for liquid water to exist on its surface, if it were present. This rocky world is a little more massive than the Earth and is the closest exoplanet to us; it may even be the closest possible abode for life beyond our own Sun. A paper describing this milestone finding is published by Nature.

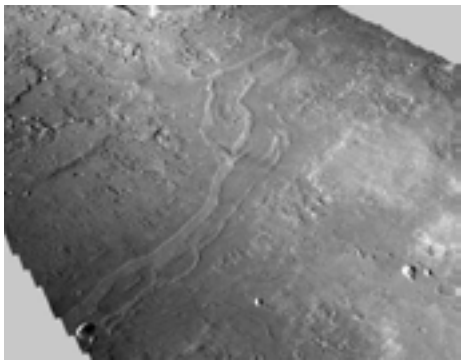
Just over four light-years from our Solar System sits a red dwarf star named Proxima Centauri. This cool star in the constellation of Centaurus is too faint to be seen with the naked eye and is close to the much brighter pair of stars known as Alpha Centauri A and B.

During the first half of 2016, the HARPS spectrograph on the European Southern Observatory's 3.6-meter telescope at La Silla regularly observed Proxima Centauri, as did other professional and amateur telescopes around the world. The team of astronomers, called the Pale Red Dot campaign, led by Carnegie alum Guillem Anglada-Escudé of Queen Mary, University of London was looking for a tiny back-and-forth wobble in the star caused by the gravitational pull of an orbiting planet.

In addition to data gathered by the Pale Red Dot campaign, the paper incorporates contributions from scientists who have been observing Proxima Centauri for years, including Butler.

As this was a topic with very wide public interest, the progress of the campaign between mid-January and April 2016 was shared publicly as it occurred ...Read More...

Fossilized rivers suggest warm, wet ancient Mars



Perspective view of Aram Dorsum, an inverted channel on Mars and candidate landing site for the ExoMars rover. Credit: NASA/JPL/MSSS

Extensive systems of fossilised riverbeds have been discovered on an ancient region of the Martian surface, supporting the idea that the now cold and dry Red Planet had a warm and wet climate about 4 billion years ago, according to UCL-led research.

The study, published in Geology and funded by the Science & Technology Facilities Council and the UK Space Agency, identified over 17,000km of former river channels on a northern plain called Arabia Terra, providing further evidence of water once flowing on Mars.

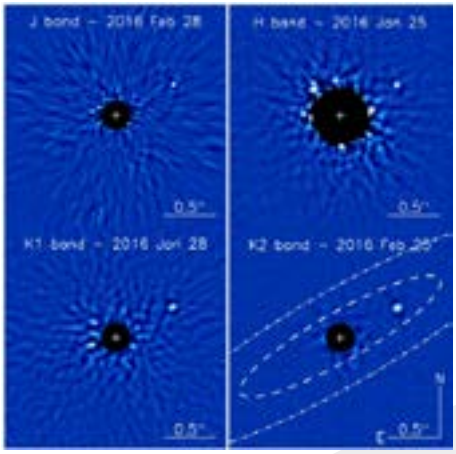
"Climate models of early Mars predict rain in Arabia Terra and until now there was little geological evidence on the surface to support this theory. This led some to believe that Mars was never warm and wet but was a largely frozen planet, covered in ice-sheets and glaciers. We've now found evidence of extensive river systems in the area which supports the idea that Mars was warm and wet, providing a more favourable environment for life than a cold, dry planet," explained lead author, Joel Davis (UCL Earth Sciences).

Since the 1970s, scientists have identified valleys and channels on Mars which they think were carved out and eroded by rain and surface runoff, just like on Earth. Similar structures had not been seen on Arabia Terra until the team analysed high resolution imagery from NASA's Mars Reconnaissance Orbiter (MRO) spacecraft.

The new study examined images covering an area roughly the size of Brazil at a much higher resolution than was previously possible - 6 metres per pixel compared to 100 metres per pixel. While a few valleys were identified, the team revealed the existence of many systems of fossilised riverbeds which are visible as inverted channels spread across the Arabia Terra plain.

The inverted channels are similar to those found elsewhere on Mars and Earth. They are made of sand and gravel deposited by a river and when the river becomes dry, the channels are left upstanding as the surrounding material erodes. On Earth, inverted channels often ...Read More...

Astronomers find a brown dwarf companion to a nearby debris disk host star



Collapsed datacubes showing HR 2562B in each of the four modes observed with GPI and reduced using KLIP. The K2 image is from February 2016 and demonstrates two possible solutions for the inner edge of the disk (38 and 75 AU with dashed and dotted-dashed lines respectively) assuming inclination of 78 degrees and position angle of 120 degrees. Credit: Konopacky et al., 2016.

Astronomers have detected a brown dwarf orbiting HR 2562 – a nearby star known to host a debris disk. The newly discovered substellar companion is the first brown dwarf-mass object found to reside in the inner hole of a debris disk. The findings were presented in a paper published Aug. 23 on the arXiv pre-print server.

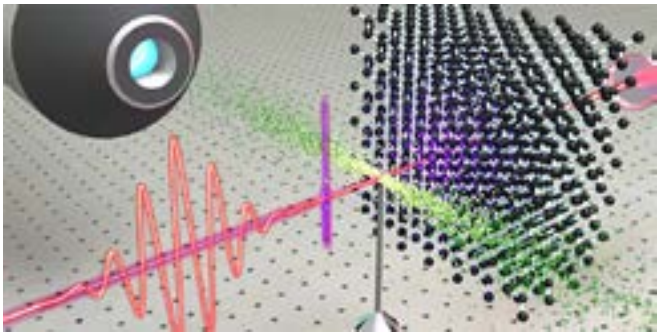
HR 2562, located some 110 light years away, is an F5V star, about 30 percent more massive than the sun. It has a debris disk—a circumstellar belt of dust and planetesimals left over from planetary formation. The disk around HR 2562, spans from 38 to 75 AU away from the host star.

In January and February 2016, a team of researchers, led by Quinn Konopacky of the University of California, San Diego, observed HR 2562 using the Gemini Planet Imager (GPI), mounted on the Gemini South Telescope in Chile. GPI is a high-contrast imaging instrument, allowing imaging and integral field spectroscopy of extrasolar planets. The observations of HR 2562 were conducted as part of the Gemini Planet Imager Exoplanet Survey (GPIES), that images young Jupiters and debris disks around nearby stars.

However, their search for a young, Jupiter-like planet resulted in a discovery of a much more massive substellar object. The data obtained during the observations, allowed the team to confirm the existence of a brown dwarf that could have at least 15 Jupiter masses. The newly found companion is separated by about 20 AU from the host star and was designated HR 2562B.

"We present the discovery of a brown dwarf companion to the debris disk host star HR 2562. ...Read More...

Electrons at the speed limit



A short laser pulse travels through a diamond (black spheres) and excites electrons inside it. The strength of the excitation is measured using an attosecond ultraviolet pulse (violet). Credit: Matteo Lucchini, ETH Zurich

Electronic components have become faster and faster over the years, thus making powerful computers and other technologies possible. Researchers at ETH Zurich have now investigated how fast electrons can ultimately be controlled with electric fields. Their insights are of importance for the petahertz electronics of the future.

Speed may not be witchcraft, but it is the basis for technologies that often seem like magic. Modern computers, for instance, are as powerful as they are because tiny switches inside them steer electric currents in fractions of a billionth of a second. The incredible data flows of the internet, on the other hand, are only possible because extremely fast electro-optic modulators can send information through fibre-optic cables in the shape of very short light pulses. Today's electronic circuits already routinely work at frequencies of several gigahertz (a billion oscillations per second) up to terahertz (a thousand billion oscillations). The next generation of electronics will therefore, sooner or later have to reach the realm of petahertz, which is a thousand times faster still. If and how electrons can be controlled that fast, however, is still largely unknown. In a groundbreaking experiment, a team led by ETH professor Ursula Keller has now investigated how electrons react to petahertz fields.

In their experiment, Keller and her collaborators exposed a tiny piece of diamond with a thickness of only 50 nanometres to an infrared laser pulse lasting a few femtoseconds (i.e., a millionth of a billionth of a second). The electric field of that laser light, having a frequency of about half a petahertz, oscillated back and forth five times in that short time and thus excited the electrons. Generally, the effect of electric fields on electrons in transparent materials can be measured indirectly by sending light through the material and then observing how strongly the material absorbs it. Whereas such measurements are easy for constant electric fields, the extremely rapidly oscillating fields of a laser beam pose a difficult challenge to the researchers. In principle, the light used for measuring the absorption should only ...Read More...

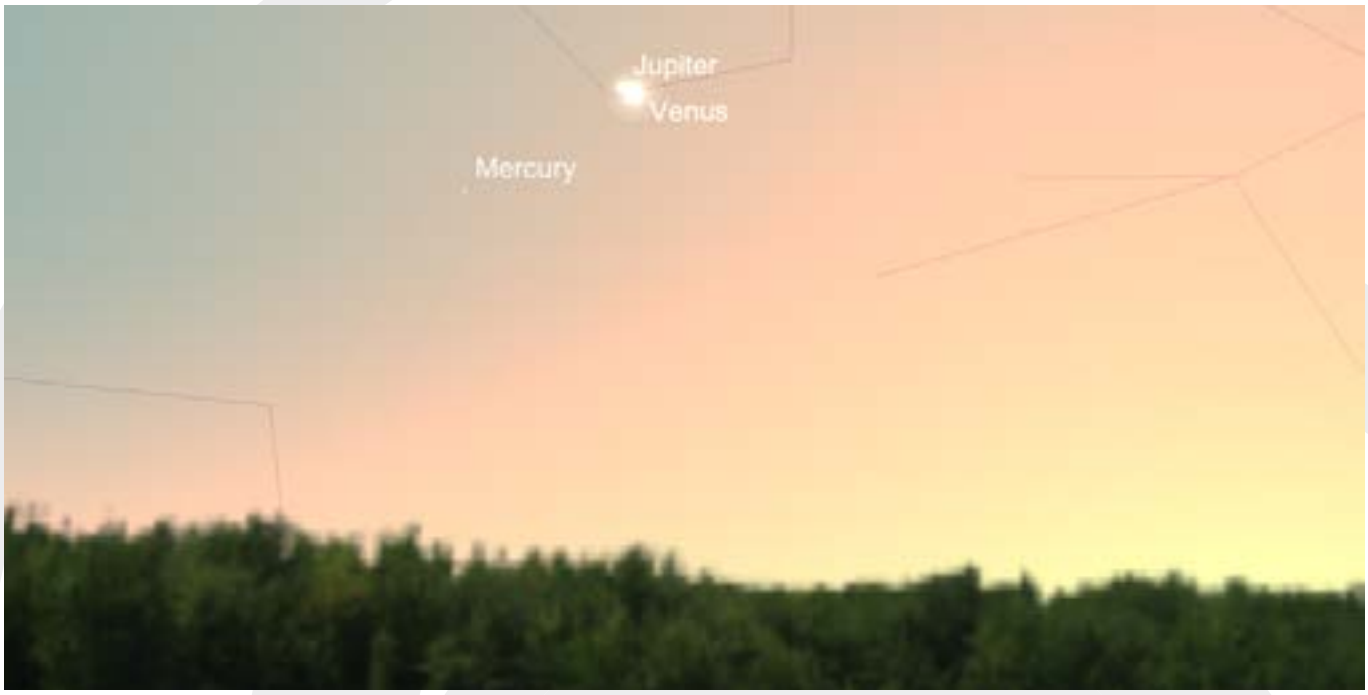
New Weekly Addition:

This Week's Sky at a Glance, Aug. 27 - Sep. 02

Sep. 01	New Moon (13:03) - Meridian passage (12:19) – Altitude: 73°
Sep. 01	Moon at ascending node (19:27)
Sep. 02	Neptune at opposition

Superb Venus-Jupiter conjunction August 27

The sky's two brightest planets Venus and Jupiter will stage the year's closest conjunction of two planets. These worlds appear only about 1/15th degree apart on the sky's dome. How close is that? Well, 1/15th of a degree is the equivalent of about 1/7th to 1/8th of the moon's apparent diameter. That's a very small span, and these two worlds will easily fit within the same binocular or telescopic field of view. ...Read More...



A nice get together of Mercury, Venus and Jupiter on August 27, 2016 looking Westaround 18:30 in Sharjah. (Starry Night Deluxe)

مـركـز الشـارقـة لعـلـوم الفضـاء والفـلك
Sharjah Center for Astronomy & Space Sciences
Sharjah Center for Astronomy and Space Sciences
Sharjah, United Arab Emirates
Phone: 00-971-6-5166000
Website: www.scass.ae
E-mail: scass@scass.ae

جامعـــة الشـــارقة
UNIVERSITY OF SHARJAH
College of Sciences - University of Sharjah
POB 27272 - Sharjah, United Arab Emirates
Phone: 00-971-6-5050351
Email: physics@sharjah.ac.ae