جامعـــة الشـــارقة
UNIVERSITY OF SHARJAH

Mar. 12, 2016
Jumada II 03, 1437
Volume 6, Issue 11

Astronomy & Physics News

Dept. of Applied Physics & Astronomy— University of Sharjah
Weekly Scientific News Compiled by Dr. Ilias Fernini

Inside this issue:

Team takes giant step forward in generating optical qubits

An optical chip developed at INRS by Prof. Roberto Morandotti's team overcomes a number of obstacles in the development of quantum computers, which are expected to revolutionize information processing. An international research team has demonstrated that on-chip quantum frequency combs can be used to simultaneously generate multiphoton entangled quantum bit (qubit) states.

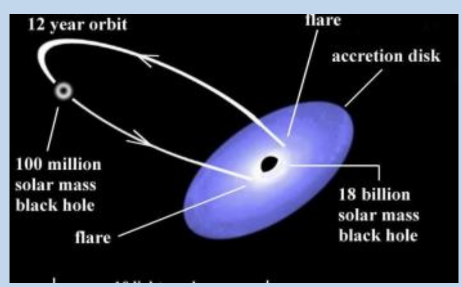
Quantum computing differs fundamentally from classical computing, in that it is based on the generation and processing of qubits. Unlike classical bits, which can have a state of either 1 or 0, qubits allow a superposition of the 1 and 0 states (both simultaneously). Strikingly, multiple qubits can be linked in so-called 'entangled' states, in which the manipulation of a single qubit changes the entire system, even if individual qubits are physically distant. This property is the basis for quantum information processing, with the goal of building superfast quantum computers and transferring information in a completely secure way. ...Read More...

In a recently published article in Science, Prof. Roberto Morandotti and his team demonstrate the generation of complex entangled quantum states on an optical chip, bringing us one step closer to practical applications in quantum information processing. Left: On-chip frequency combs for scalable, complex quantum state generation. Top right: Quantum frequency comb of entangled photons. Bottom right: Photonic chip – compatible with common semiconductor fabrication technologies. Credit: Ultrafast Optical Processing Group, 2016.

Clocking the rotation rate of a supermassive black hole

A recent observational campaign involving more than two dozen optical telescopes and NASA's space based SWIFT X-ray telescope allowed a team of astronomers to measure very accurately the rotational rate of one of the most massive black holes in the universe. The rotational rate of this massive black hole is one third of the maximum spin rate allowed in General Relativity. This 18 billion solar mass heavy black hole powers a quasar called OJ287 which lies about 3.5 billion light years away from Earth. Quasi-stellar radio sources or `quasars' for short, are the very bright centers of distant galaxies which emit huge amounts of electro-magnetic radiation due to the infall of matter into their massive black holes.

This quasar lies very close to the apparent path of the Sun's motion on the celestial sphere as seen from Earth, where most searches for asteroids and comets are conducted. Therefore, its optical photometric measurements already cover more than 100 years. A careful analysis of these observations show that OJ 287 has produced quasi-periodic optical outbursts at intervals of approximately 12 years dating back to around 1891. Additionally, a close inspection of newer data sets reveals the presence of double-peaks in these outbursts….Read More...



An illustration of the binary black hole system in OJ287. The predictions of the model are verified by observations. Credit: Gary Poyner, UK

Creation of first practical silicon-based laser

A group of researchers from the UK, including academics from Cardiff University, has demonstrated the first practical laser that has been grown directly on a silicon substrate.

It is believed the breakthrough could lead to ultra-fast communication between computer chips and electronic systems and therefore transform a wide variety of sectors, from communications and healthcare to energy generation.

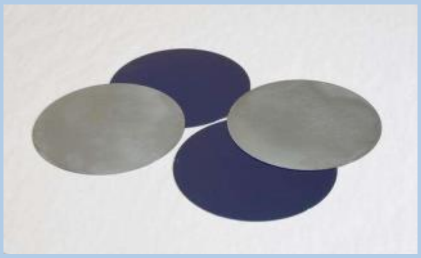
The EPSRC-funded UK group, led by Cardiff University and including researchers from UCL and the University of Sheffield, have presented their findings in the journal Nature Photonics.

Silicon is the most widely used material for the fabrication of electronic devices and is used to fabricate semiconductors, which are embedded into nearly every device and piece of technology that we use in our everyday lives, from smartphones and computers to satellite communications and GPS.

Electronic devices have continued to get quicker, more efficient and more complex, and have therefore placed an added demand on the underlining technology.

Researchers have found it increasingly difficult to meet these demands using conventional electrical interconnects between computer chips and systems, and have therefore turned to light as a potential ultra-fast connector.

Whilst it has been difficult to combine a semiconductor laser - the ideal source of ...Read More...



SIlicon wafer

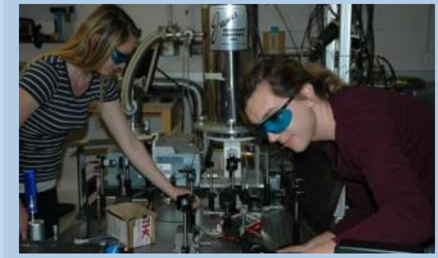
New material can control excitons at room temperature

A team of physicists from the University of California, San Diego and The University of Manchester is creating tailor-made materials for cutting-edge research and perhaps a new generation of optoelectronic devices. The materials make it easier for the researchers to manipulate excitons, which are pairs of an electron and an electron hole bound to each other by an electrostatic force.

Excitons are created when a laser is shone onto a semiconductor device. They can transport energy without transporting net electric charge. Inside the device the excitons interact with each other and their surroundings, and then convert back into light. This makes them attractive for new technology. Inside the device the excitons interact with each other and their surroundings, and then convert back into light that can be detected by extremely sensitive charge-coupled device (CCD) cameras.

Most of the team's previous work involved structures based on gallium arsenide (GaAs), which is a material commonly used throughout the semiconductor industry. Unfortunately, the devices they've developed come with a fundamental limitation: They require cryogenic temperatures (below 100 K)—ruling out any commercial applications.

So the team made a radical material change to bring their excitonic devices up to room temperature. They report their results in Applied Physics Letters….Read More...



Erica Calman and Chelsey Dorow align optics required to collect measurements from a molybdenum disulfide sample. Credit: Calman

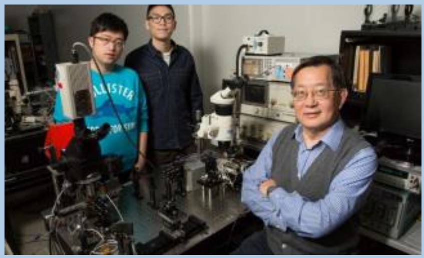
Light helps the transistor laser switch faster

Light and electrons interact in a complex dance within fiber optic devices. A new study by University of Illinois engineers found that in the transistor laser, a device for next-generation high-speed computing, the light and electrons spur one another on to faster switching speeds than any devices available.

Milton Feng, the Nick Holonyak Jr. Emeritus Chair in electrical and computer engineering, found the speed-stimulating effects with graduate students Junyi Qiu and Curtis Wang and Holonyak, the Bardeen Emeritus Chair in electrical and computer engineering and physics. The team published its results in the Journal of Applied Physics.

As big data become bigger and cloud computing becomes more commonplace, the infrastructure for transferring the ever-increasing amounts of data needs to speed up, Feng said. Traditional technologies used for fiber optic cables and high-speed data transmission, such as diode lasers, are reaching the upper end of their switching speeds, Feng said. "You can compute all you want in a data center.

However, you need to take that data in and out of the system for the user to use," Feng said. "You need to transfer the information for it to be useful, and that goes through these fiber optic interconnects. But there is a fundamental switching limitation of the diode laser used. This technology, the transistor laser, is the next-generation ..Read More.



Graduate students Junyi Wu and Curtis Wang and professor Milton Feng found that light stimulates switching speed in the transistor laser, a device they hope will usher in the next generation of high-speed data transmission. Credit: L. Brian Stauffer

Death by gamma-ray bursts may place first lower bound on the cosmological constant

Sometimes when a star collapses into a supernova, it releases an intense, narrow beam of gamma rays. Gamma-ray bursts often last just a few seconds, but during that time they can release as much energy as the Sun will produce in its entire lifetime, making gamma-ray bursts the most powerful explosions ever observed in the universe. They are so intense that, if pointed at the Earth from even the most distant edge of our galaxy, they could easily cause a mass extinction, possibly obliterating all life on the planet. It's thought that a gamma-ray burst may have caused the Ordovician extinction around 440 million years ago, which wiped out 85% of all species at the time.

Clearly, the farther away a planet is from gamma-ray bursts, the better its chances of harboring advanced forms of life. In a new paper, scientists have shown that the gamma-ray burst risk to life favors a universe where all objects (like planets and gamma-ray bursts) are relatively far apart. And the main factor that tells how far apart everything is in the universe—or in other words, how things are spreading out and moving away from each other—is dark energy or the cosmological constant.

One of the biggest unanswered questions in cosmology is why does the cosmological constant have the particular value that scientists observe? Einstein initially devised the cosmological constant to be like an "anti-gravity" force, so that a larger value means that the universe is expanding very rapidly and objects are being pushed farther apart ...Read More...

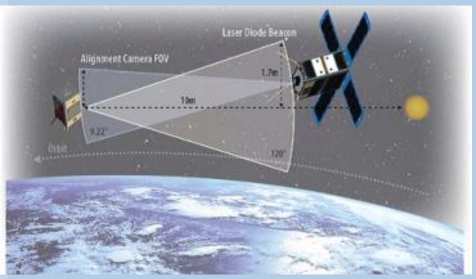
Artist's illustration of a gamma-ray burst. Energy from the explosion is beamed into two narrow, oppositely directed jets. Credit: NASA/Swift/Mary Pat Hrybyk-Keith and John Jones

CANYVAL-X: Two CubeSats, One Telescope

An international team is seeking to field a unique pair of astronomy satellites later this year, a duo that will test free-flying coronagraphs for future missions.

The CANYVAL-X (CubeSat Astronomy by NASA and Yonsei using Virtual Telescope Alignment eXperiment) mission will feature a pair of small satellites flying as a tandem telescope, one carrying the optics and the other carrying the detector. Flying in formation allows one satellite to block a celestial target from the point of view of the other satellite. This coronagraph will enable astronomers to study objects close to a bright source, such as exoplanets near bright parent stars or the Sun's elusive corona.

"CANYVAL-X is an engineering proof of concept," says project manager Neerav Shah (NASA Goddard Space Flight Center). The mission's purpose is to test how precisely two independent satellites can be aligned in space. Though missions such as the Solar Heliospheric Observatory have built-in coronagraphs, and other missions have demonstrated free-flying tandem capabilities ...Read More...



An artist's concept of the two CANYVAL-X satellites in orbit.
NASA/Brittany Klein

Message from aliens or colliding objects? The hunt for enigmatic radio bursts is about to get real

Astronomers are getting ever closer to understanding the origin of mysterious "fast radio bursts" – very brief but intense pulses of radio waves from outer space – after a series of recent contradictory findings. While the cause of these powerful blips is still unknown, scientists' eagerness to find out is driving a renaissance in radio astronomy. Along with a revolution in our ability to map huge chunks of the sky in real time over the coming decade, this means the hunt for an answer is starting to look promising.

he first discovery of a fast radio burst, lasting only 5 milliseconds, was announced in 2007 by scientists mining data from Australia's Parkes radio telescope. Unfortunately, the burst did not repeat, so it couldn't be independently confirmed by others. Several years passed before new bursts were found at different locations in the sky using independent telescopes in Arecibo, Puerto Rico and Greenbank, US.

But astronomers failed to agree on what had caused the bursts. As they had been one-off blips, more like whistlers than repeating signals, it was suggested that they could come from catastrophic one-off events – such as a neutron star colliding with a black hole. Other explanations included huge flashes of brightness, similar to solar flares, from stars in our own galaxy, or simply contaminating signals from radio waves emitted on Earth. Some even speculated that the signals could be transmitted by distant alien civilisations.

Bewildering results

On March 2, it seemed the mystery had finally been solved when scientists ...Read More….

Artist's impression of the Square Kilometre Array, which will revolutionise our ability to detect fast radio bursts. Credit: SKA Project Development Office and Swinburne Astronomy Productions - Swinburne Astronomy Productions for SKA Project Development Office, CC BY-ND

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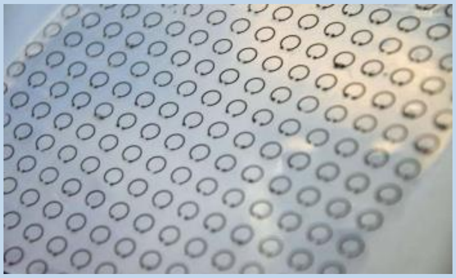
Engineers develop flexible skin that traps radar waves, cloaks objects

Iowa State University engineers have developed a new flexible, stretchable and tunable "meta-skin" that uses rows of small, liquid-metal devices to cloak an object from the sharp eyes of radar.

The meta-skin takes its name from metamaterials, which are composites that have properties not found in nature and that can manipulate electromagnetic waves. By stretching and flexing the polymer meta-skin, it can be tuned to reduce the reflection of a wide range of radar frequencies.

The journal Scientific Reports recently reported the discovery online. Lead authors from Iowa State's department of electrical and computer engineering are Liang Dong, associate professor; and Jiming Song, professor. Co-authors are Iowa State graduate students Siming Yang, Peng Liu and Qiugu Wang; and former Iowa State undergraduate Mingda Yang. The National Science Foundation and the China Scholarship Council have partially supported the project.

"It is believed that the present meta-skin technology will find many applications in electromagnetic frequency tuning, ...Read More...



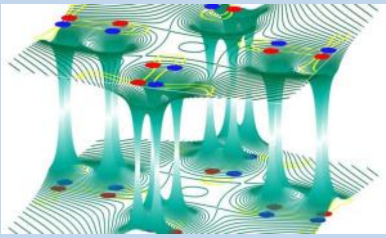
This flexible, stretchable and tunable "meta-skin" can trap radar waves and cloak objects from detection. Credit: Liang Dong/Iowa State University

Down the rabbit hole: How electrons travel through exotic new material

Researchers at Princeton University have observed a bizarre behavior in a strange new crystal that could hold the key for future electronic technologies. Unlike most materials in which electrons travel on the surface, in these new materials the electrons sink into the depths of the crystal through special conductive channels.

"It is like these electrons go down a rabbit hole and show up on the opposite surface," said Ali Yazdani, the Class of 1909 Professor of Physics. "You don't find anything else like this in other materials." The research was published in the journal Science.

Yazdani and his colleagues discovered the odd behavior while studying electrons in a crystal made of layers of tantalum and arsenic. The material, called a Weyl semi-metal, behaves both like a metal, which conducts electrons, and an insulator, which blocks them. A better understanding of these and other "topological" materials someday could lead to new, faster electronic devices….Read More...

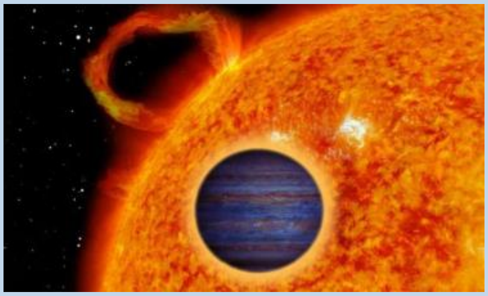


New research from Princeton University demonstrates the bizarre movement of electrons through a novel material called a Weyl semi-metal. The image shows a schematic of the connections at special values of electron momentum, which come in pairs and ...

Astronomers discover two new 'hot Jupiter' exoplanets

A team of Chilean astronomers recently detected two new "hot Jupiters" using the data from NASA's Kepler spacecraft operating in a new mission profile called K2. The planets, designated EPIC210957318b and EPIC212110888b, were discovered via the radial velocity method, and are excellent candidates for further orbital and atmospheric characterization via detailed follow-up observations. A research paper describing the discovery appeared online on Mar. 5, on the arXiv server.

The so-called "hot Jupiters" are gas giant planets, similar in characteristics to the solar system's biggest planet, with orbital periods of less than 10 days. They have high surface temperatures as they orbit their parent stars very closely—between 0.015 and 0.5 AU—while Jupiter orbits the sun at 5.2 AU. To date, about 250 transiting "hot Jupiters" have been found, mostly by ground-based photometric surveys. Now, the researchers have made use of a space-borne telescope to detect new, interesting hot giant exoworlds. ...Read More...



Artist's impression of a 'hot Jupiter'. Credit: Ricardo Cardoso Reis (CAUP)