Volume 7, Issue 42 ■ 20OCT2017

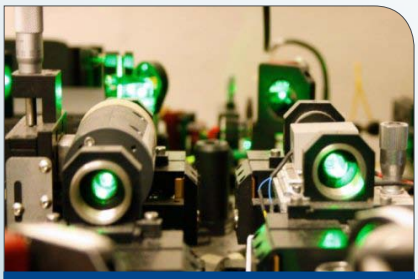
S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

FEATURE ARTICLES

Single photon reveals quantum entanglement of 16 million atoms

Science Daily, 13OCT2017



This is a partial view of the source producing the single photons that were stored in the quantum memory to produce entanglement between many atoms inside the memory. Credit: UNIGE

An international team of researchers (Germany, USA - University of Oregon, Switzerland) developed an entanglement witness for quantifying the number of genuinely entangled particles based on the collective effect of directed emission combined with the non-classical nature of the emitted light. They examined the characteristics of light re-emitted by the crystal, as well as analysing its statistical properties and probabilities. They succeeded in showing the entanglement of 16 million atoms when previous observations had a ceiling of a few thousand. OPEN ACCESS TECHNICAL ARTICLE

Tags: Quantum science, S&T Switzerland, Featured Article

Invisibility is within sight

Science Daily, 09OCT2017

An international team of researchers (Singapore, Australia) has shown that, theoretically, transparent particles with extraordinarily high refractive indices can become almost invisible at wavelengths longer than the particle size. They found that the electric dipole mode in small particles of such materials is suppressed by the emergence of another dipole mode, resulting in ultra-weak scattering below the Rayleigh limit. The challenge now is to find or develop materials with a high enough refractive index at the wavelength of interest to suppress Rayleigh scattering. The discovery could lead to a new class of 'invisible' materials. TECHNICAL ARTICLE

Tags: Photonics, Materials science, Featured Article

S&T NEWS ARTICLES

ADVANCED MATERIALS

Researchers offer insights into lightweight material that expands with heat

Physorg.com, 16OCT2017

An international team of researchers (South Korea, University of Pennsylvania) created "microbombs," a type of material that expands with heat to form "microclusters," which fit themselves to fill their physical confinement. They were able to create microclusters with a wide variety of shapes (circles, triangles, squares, pentagons and hexagons) and partitions, edge profiles and hierarchy. The micro-nanopatterns could be transferred onto the surface of the microclusters. The technique could be used to provide heat and acoustic insulation and by inscribing patterns on the microclusters, they hope to mimic complex structures which allow temperature control. OPEN ACCESS TECHNICAL ARTICLE

Tags: Advanced materials

Nanosheet actuators lift 150 times their own weight

Nanotechweb, 13OCT2017

Based on the principle of ion intercalation, researchers at Rutgers University developed an electrochemical actuator made from nanosheets of molybdenum disulphide using a flexible Kapton beam as a substrate. Intercalation causes the structure to become longer and thinner. The extent of the size change depends on the concentration of intercalated ions. By applying a voltage across the system, the change in length induced a strain in the substrate, causing it to bend and serve as an actuator. They altered the voltage and measured the curvature over more than 8000 cycles and found no signs of degradation. These results could lead to new electrochemical actuators for high-strain and high-frequency applications. TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

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Octopus-inspired material morphs from flat to 3D

Futurity.com, 13OCT2017

Inspired by cephalopod muscular morphology, a team of researchers in the US (Cornell University, Marine Biological Laboratory at Woods Hole) has developed synthetic tissue groupings consisting of elastomeric membranes embedded with inextensible textile mesh that allowed programmable transformation of 2D stretchable surfaces into target 3D shapes. It inflated to within 10% of their target shapes by using a simple fabrication method and modeling approach. The discovery has applications in robotics and for camouflage. TECHNICAL ARTICLE

Tags: Advanced materials, Biomimetics

Researchers show materials strengthen on their own when impacted at very high speed

Physorg.com, 10OCT2017

A team of researchers in the US (MIT, ARL, Maryland) discovered that when targets made of poly(urethane urea) elastomers (PUU) are impacted at very high speed by micro-particles made of silica, they become extremely stiff when deformed at strain rates on the order of 108/s. It deforms to half of its original thickness in an extremely short time and bounces back after the impact. The resistance against penetration of the micro-particle can be optimized, i.e. a ~50% reduction in the average maximum depth of penetration was achieved by simply varying the molecular composition of PUUs. They hypothesize that high-rate deformation-induced glass transition is a plausible molecular relaxation mechanism towards macroscopic, dynamic stiffening/strengthening in PUUs. The discovery can help design matrix materials for composites for the future generation of U. S. Army combat helmets. TECHNICAL ARTICLE

Tags: Advanced materials, Materials science, Military technology

Spin-current generation gets mid-infrared boost with plasmonic metamaterial

Physorg.com, 10OCT2017

A team of researchers in Japan created a spintronic device made up of separate layers of platinum (Pt) and magnetic insulator yttrium iron garnet (YIG). They placed layers of alumina and aluminum on the Pt layer to create the PMA on top of the spintronic device. They showed that spin current can be generated directly from the absorbed photons in the Pt film. Because light is confined in the subwavelength regime in the PMA, electromagnetic fields are strongly enhanced before the light is absorbed. Combining mid-infrared plasmonic metamaterials with spintronic devices enables stronger light absorption and shows the excellent tenability of these metamaterials' resonance wavelengths. The research has applications from thermophotovoltaics and ultrathin film solar cells to light and thermal detectors. OPEN ACCESS TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

Superhero technology flexes its muscles to help save lives

University of Delaware, 10OCT2017

A team of researchers in the US (University of Delaware, ARL) has developed shear thickening fluids (STF) which permeate fabrics making it stronger. STF is light and flexible. When a body armor treated with STF is hit by an object or shaken forcefully, under the mechanical stress the tiny particles of silica and polymers suspended in STF harden instantly forming a protective shield. The hardening process occurs in milliseconds, and then the body armor becomes flexible again. It also provides stab and puncture protection. The technology can be customized based upon the threat and desired performance characteristics.

Tags: Advanced materials, Military technology

BIOTECHNOLOGY

Synthetic 'purple membranes' transform sunlight to hydrogen fuel

Nanowerk, 13OCT2017

An international team of researchers (USA - Argonne National Laboratory, Northwestern University, Russia) found a new way to produce solar fuels by developing completely synthetic bionano machinery to harvest light without the need for living cells. To create the synthetic version of the membrane protein, the researchers used the nanodiscs, synthetic DNA that encoded the protein, and ribosome-protein manufacturing machinery. The synthetic membranes were assembled with nanoparticles of titanium dioxide for hydrogen evolution under visible light. The system produced hydrogen with similar or even higher efficiency compared to systems based on bacterial purple membrane. The semiconductor's ability to harness energy from visible light as opposed to UV light is central to renewable energy research. OPEN ACCESS TECHNICAL ARTICLE

Tags: Biotechnology, Energy, Solar energy

COMMUNICATIONS TECHNOLOGY

Researchers implement entanglement swapping with independent sources over 100km optical fiber

Physorg.com, 12OCT2017

Researchers in China exploited two independent 1 GHz-clock sequential time-bin entangled photon-pair sources, developed several automatic stability controls, and successfully implemented a field test of entanglement swapping over a 103 km optical fiber link composed of about 77 km of optical fiber inside the lab, 25 km of optical fiber outside the lab but kept underground, and 1 km of optical fiber suspended in the air outside the lab to account for various types of noise mechanisms in the real world. The results show that realizing entanglement swapping between two cities is technically feasible, even if more

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"Basic research is a long-term process - it ceases to be basic if immediate results are expected on short-term support." VANNEVAR BUSH

suspended fiber is used. The experiment also verifies the feasibility of such technologies for long distance quantum networks and opens new possibilities for future applications in more complicated environments. OPEN ACCESS TECHNICAL ARTICLE

Tags: Communications technology, Quantum science, S&T China

CYBER SECURITY

Serious flaw in WPA2 protocol lets attackers intercept passwords and much more

Arstechnica.com, 16OCT2017

Researchers in Belgium have disclosed an exploit called KRACK (Key Reinstallation Attacks) that affects the core WPA2 protocol itself and is effective against devices running Android, Linux, and OpenBSD, and to a lesser extent macOS and Windows, as well as MediaTek Linksys, and other types of devices. The website disclosing the vulnerability warned that attackers can exploit the flaw to decrypt a wealth of sensitive data that's normally encrypted by the nearly ubiquitous Wi-Fi encryption protocol. KRACK allows attackers within range of the vulnerable device or access point to intercept passwords, e-mails, and other data presumed to be encrypted, and in some cases, to inject ransomware or other malicious content into a website a client is visiting.

Tags: Cyber security

Stress-Testing a Hypothetical Global Grid

IEEE Spectrum, 10OCT2017

DOE's Idaho National Laboratory led an international team in testing the Real-Time Super Lab (TR) to learn how electricity can be rerouted across vast distances to rapidly stabilize grids after a disruption and whether multiple systems on different continents could work simultaneously to balance the grid after a simulated disruption. To mitigate latency issues identified by a 2015 experiment, they used advanced methods from the fields of signal processing, filtering theory, and data compression. The RT Super Lab has the ability to move electrons across oceans as a result of powerful computing tools working simultaneously to respond to demand and supply signals. The current experiment demonstrated that widely dispersed computing assets can indeed simultaneously solve a grid stability problem. The research is considering additional "what if" scenarios involving energy storage devices, renewable energy resources, and hydroelectric generating capacity.

Tags: Cyber security, Energy

ENERGY

Converting carbon dioxide to carbon monoxide using water, electricity

Science Daily, 12OCT2017

To understand how electrocatalysts in fuel cells or electrochemical cells work, a team of researchers in the US (Lawrence Berkeley National Laboratory, University of Illinois, University of Minnesota, UC Berkeley) has developed a multiscale framework for ab initio simulation of the electrochemical reduction of CO_2 over an Ag surface. They examined three alternative mechanisms for CO_2 reduction. The multiscale simulation made it possible to identify the mechanism that leads to the dependence of the rate of CO formation on the partial pressure of CO_2 that is consistent with experiments. The discovery can lead to the development of efficient electrocatalysts for large scale production of synthesis gas. TECHNICAL ARTICLE

Tags: Energy

Batteries of the future: Low-cost battery from waste graphite

Science Daily, 11OCT2017

In conventional Li-ion batteries, the anode is made of graphite, the layers of which contain lithium ions. Researchers in Switzerland designed a battery using synthetic kish graphite, which is a byproduct of steel making, as a cathode and a metal as the anode. For several months, a lab system survived thousands of charging and discharging cycles. The exceptional electrochemical behavior of kish graphite flakes is mainly determined by the high structural order of carbon atoms, low level of defects, and unique "crater morphology." In tests, they obtained energy densities of up to 65 Wh kg^{-1}. The kish graphite flakes can rapidly charge and discharge, offering high power densities of up to 4363 W kg^{-1}. TECHNICAL ARTICLE

Tags: Energy, Battery, S&T Switzerland

Organic/inorganic sulfur may be key for safe rechargeable lithium batteries

Nanowerk, 11OCT2017

Li metal reacts with electrolytes to instantly form a solid-electrolyte interphase (SEI) layer on the Li surface. Li metal protrusions grow out of breaks in the SEI layer to form dendrites causing safety hazards. Researchers at Pennsylvania State University designed and demonstrated a stable and flexible SEI layer through self-formation of hybrid inorganic/organic Li compounds onto the Li metal. The organic units in the hybrid serve as a "plasticizer"

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in the SEI layer to improve its flexibility and toughness, while Li-containing inorganic units in the hybrid provide Li conductive pathways. Stable and flexible SEI layers enable uniform Li deposition and suppress growth of Li dendrites. They reported a battery exhibiting a long cycling life—1000 cycles—and good capacity retention. Open Access TECHNICAL ARTICLE

Tags: Energy, Battery

Storage is renewable energy's greatest challenge -- this low-cost sulfur battery may help

Science Daily, 11OCT2017

Researchers at MIT have demonstrated an ambient-temperature aqueous rechargeable flow battery that uses low-cost polysulfide anolytes in conjunction with lithium or sodium counter-ions, and an air- or oxygen-breathing cathode. The solution energy density, at 30–145 Wh/L depending on concentration and sulfur speciation range, exceeds current solution-based flow batteries, and the cost of active materials per stored energy is exceptionally low, $1/kWh when using sodium polysulfide. Open Access TECHNICAL ARTICLE

Tags: Energy, Battery

Featured Resource

NASA Technical Reports Server (NTRS)

NTRS provides access to aerospace-related citations, full-text online documents, conference papers, journal articles, meeting papers, patents, research reports, images, movies, and technical videos created or funded by NASA. RSS .

ENVIRONMENTAL SCIENCE

Removing carbon from atmosphere can be simple and low tech

Next Big Future, 11OCT2017

The article lists simple, low cost and scalable carbon dioxide mitigation since 2009. According to the authors, these methods will be faster to scale than complicated and industrial intensive carbon capture at coal and natural gas plants and factories and create massive national and global pipelines to move the captured gas into underground storage.

Tags: Environmental science, Climatology

FOREIGN S&T

North Korea's Biological Weapons Program: The Known and Unknown

Harvard Kennedy School, 01OCT2017

In this paper, researchers at the Harvard Kennedy School examine the state of knowledge on North Korea's BW program. Using publicly available information, including articles, books, governmental and non-governmental reports, as well as interviews with subject matter experts and former government officials, the authors map the known and unknowns of North Korea's BW program. They focus their analysis on the policies of South Korea and the United States. They present recommendations on how to improve assessment and surveillance of North Korea's BW program, especially with new technologies, and how to improve current policies regarding North Korea's BW program. NK Bioweapons: Known and Unknown

Tags: Foreign S&T, Counter WMD, S&T Policy

IMAGING TECHNOLOGY

VConv-DAE: Deep Volumetric Shape Learning Without Object Labels

Max Planck Institute, 13OCT2017

An international team of researchers, (Germany, USA - industry) working under the EU Horizon 2020 program, has developed a method that can reconstruct a digital object even from incomplete images. They propose a full convolutional volumetric auto encoder that learns volumetric representation from noisy data by estimating the voxel occupancy grids. The proposed method outperforms prior work on challenging tasks like denoising and shape completion. They showed deep embedding gives competitive performance when used for classification and promising results for shape interpolation. They plan to extend the work to deal with deformable objects and larger scene. Open Access TECHNICAL ARTICLE

Tags: Imaging technology

MATERIALS SCIENCE

Hydrogel that extracts uranium from water wins MADMEC

MIT News, 13OCT2017

There is about 4 billion tons of uranium in seawater, compared to 10 million tons on land. A team of students at MIT has developed a prototype of a simple, low-cost hydrogel called Salt Solution, which is a chain of hydrophilic polymer, that can be incorporated into water desalination plants or placed directly into bodies of water. Uranium accumulates on the hydrogel's surface for extraction. The polymer can be purchased at industrial scales for much lower costs. The hydrogel is simple to make, based on well-developed technology with a slight modification and an economically feasible material that can passively collect uranium from water.

Tags: Materials science, Advanced materials

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New method to detect spin current in quantum materials unlocks potential for alternative electronics

Nanowerk, 13OCT2017

A team of researchers in the US (Oak Ridge National Laboratory, University of Florida, Purdue University) developed and tested a microscopy technique to detect the spin of electrons on a single crystal of Bi_2Te_2Se. It measured how much voltage was produced along the material's surface as the flow of electrons moved between specific points while sensing the voltage for each electron's spin. They successfully detected voltage generated by the electron's spin current. The work provides clear evidence of the spin current in topological insulators and opens a new avenue to study other quantum materials that could be used in next-generation electronic devices. TECHNICAL ARTICLE

Tags: Materials science, Advanced materials

Researchers create atom-thick alloys with unanticipated magnetic properties

Nanowerk, 11OCT2017

An international team of researchers (USA - Rice University, Oak Ridge National Laboratory, University of Southern California, Japan) used CVD to grow monolayer 2D alloys of Re-doped $MoSe_2$. They confirmed the theory that adding rhenium in various amounts to molybdenum diselenide during growth would allow them to tailor its properties by changing its atomic structure which led to changes in the mechanical and electronic properties of the flat crystals. The magnetic properties they discovered could make the 2-D alloys of interest to those who design spintronic devices. TECHNICAL ARTICLE

Tags: Materials science, Advanced materials

Building a barrier against oxidation

Science Daily, 09OCT2017

Researchers in Singapore have demonstrated that placing phosphorene on a molybdenum diselenide substrate and applying a vertical electric field can drastically increase its resistance to oxidation. The interaction and charge transfer between substrate and phosphorene can be tuned by an external electric field, causing a change in surface activity and suppressing the oxidation of phosphorene. The research may greatly promote the use of phosphorene in practical devices. The researchers are exploring other substrates for their ability to stabilize phosphorene. TECHNICAL ARTICLE

Tags: Materials science, Advanced materials

MICROELECTRONICS

Seeing the next dimension of computer chips

Nanowerk, 10OCT2017

More transistors can be crammed in FETs. However, this method requires a silicon crystal with a perfectly flat top and side-surfaces, instead of just the top surface, as with current devices. Researchers in Japan have created images of the side-surface of a silicon crystal proving that we can make artificial 3D structures with near-perfect atomic surface ordering. The knowledge of the atomic structures of the side-surfaces helps the semiconductor industry continue to innovate while producing smaller, faster, and more energy-efficient computer chips. TECHNICAL ARTICLE

Tags: Microelectronics, S&T Japan

NEUROSCIENCE

Hacking Brain Waves Can Give You an Instant Cognitive Boost, Says Study

Science News Alert, 11OCT2017

Researchers at Boston University concentrated on two brain regions in particular: the medial frontal cortex and the lateral prefrontal cortex. In tests, when they increased synchronicity between brain areas, the volunteers learned faster, made fewer errors, and recovered from errors more quickly. On the other hand, when the oscillations between the brain regions were disrupted, people in the group made more errors and were slower to learn. In tests where the oscillations were disrupted then synchronised more quickly than before during the tasks, the original thought patterns and levels of learning came back within minutes. According to the researchers, although synchronization could help conditions like anxiety, autism, ADHD, etc., it is not clear if it could give healthy brains a boost in their thought processes. TECHNICAL ARTICLE

Tags: Neuroscience

Scientists Can Read a Bird's Brain and Predict Its Next Song

MIT Technology Review, 11OCT2017

A team of researchers in the US (UC San Diego, Kavli Institute for Brain and Mind) has developed a Brain Machine Interface (BMI) for birdsong, that decodes a complex, learned vocal behavior, and figures out the song a finch is going to sing a fraction of a second before it does so. They used silicon electrodes in awake birds to measure the electrical chatter of neurons in part of the brain where commands that shape the production of learned song originate. They fed into the program both the pattern of neural firing and the actual song that resulted. The idea was to train their software to match one to the other. The team's main innovation was to simplify the brain-to-tweet translation by incorporating a physical model of how finches make noise. According to the researchers, a similar approach could fuel advances towards a human thought-to-text interface. OPEN ACCESS TECHNICAL ARTICLE

Tags: Neuroscience

PHOTONICS

Topological Laser Cavities Could Revolutionize Optoelectronics

IEEE Spectrum, 12OCT2017

Researchers at UC San Diego overcame the constraint on shape by building quantum wells out of indium gallium arsenide phosphide and placing them inside photonic crystals made from yttrium iron garnet. A photonic crystal has a crystalline structure on the same size scale as the wavelength of light passing through it, and the structure acts as a mirror, steering light along a desired path. The crystals had different topologies, one had the basic crystalline shape and the other was a triangular lattice with cylindrical air holes. The interface where the two meet become the laser cavity. Using this technology, lasers can be packed more densely onto a chip leading to higher speed optical communications and new types of photonic devices. TECHNICAL ARTICLE

Tags: Photonics

S&T POLICY

Oxford Is Creating a World First Zero Emission Zone by 2035

Science News Alert, 14OCT2017

The levels of nitrogen dioxide in the centre of Oxford, England, have been dropping but remain dangerously high. According to the authorities, only allowing zero-emission vehicles into Oxford city centre by 2035 would cut down nitrogen dioxide to "near-background levels", a reduction of up to 74 percent on some of Oxford's streets. More broadly, the UK is planning to ban the sale of new petrol and diesel vehicles by 2040. France has committed to the same year, and China is planning a similar move, though it hasn't decided on a timeline yet.

Tags: S&T policy

Climate change may accelerate infectious disease outbreaks, say researchers

Science Daily, 12OCT2017

According to a new study by an international team of researchers (USA - University of Colorado, Columbia University, SUNY Syracuse, Ecuador), climate change presents complex and wide-reaching threats to human health. It can amplify and unmask ecological and socio-political weaknesses and increase the risk of adverse health outcomes in socially vulnerable regions. These vulnerabilities can happen anywhere. The warmer temperatures and increased rainfall from El Niño have previously been associated with a higher likelihood of dengue outbreaks. Warmer temperatures can also accelerate viral replication in mosquitoes and influence mosquitos' development and breeding habits. OPEN ACCESS TECHNICAL ARTICLE

Tags: S&T policy, Climatology

SCIENCE WITHOUT BORDERS

China wants to open major Arctic shipping route

Next Big Future, 13OCT2017

China's state news agency reported last month that, for eight days, a Chinese ship, the Xue Long (or Snow Dragon), traveled for 2,300 nautical miles through waters claimed by Canada, and conducted a successful test of a trading route along the Arctic Northwest Passage. For China, the Northwest Passage could become a new notch in its multibillion-dollar logistics program known as the Belt and Road Initiative. The appeal includes the shortening of trade routes between China and North America. A Shanghai-to-New York route, for example, stretches 10,500 nautical miles through the Suez Canal. The Northwest Passage would cut that route by nearly 2,000 nautical miles and seven days of transit time.

Tags: Science without borders

SENSORS

Plasmons in an open box create miniature laser

Physorg.com, 13OCT2017

An international team of researchers (USA - NIST, University of Maryland, University of Michigan, China) has achieved narrow-line width visible-frequency lasing at room temperature by leveraging surface plasmons propagating along the floor of an open metallic trench made by moulding silver. The design enabled the surface plasmon polaritons (SPPs) to bounce back and forth across the cavity hundreds of times without losing significant energy. The high Q also enabled the cavity to act as an extremely selective filter for SPPs enabling the resonant cavity to become a highly sensitive detector of tiny changes in its environment. The laser could act as a nanoscale device to sense minute amounts of pollutants and other chemicals in the environment, or detect the surface binding of biomolecules for medical diagnostics. OPEN ACCESS TECHNICAL ARTICLE

Tags: Sensors

In a first for wearable optics, researchers develop stretchy fiber to capture body motion

Science Daily, 12OCT2017

Researchers in China have developed a sensor based on dye-doped polydimethylsiloxane optical fiber, which enables the quantitative detection of tensile strains by absorption changes of the light passing through the dye-doped fiber. Elaborate mechanical and strain tests confirm durability, reliability, and long-term stability of the sensor device. The sensor exhibits linear and repeatable responses in a large dynamic range up to 100%. When tested in different environments, such

as in water, glycerol and air, the fibers held up well, although the sensing accuracy did change in different environments, suggesting the sensors would need to be calibrated for the specific environment they'd be used in. The technology captures a more detailed level of motion which may help in designing robots and health monitors.
TECHNICAL ARTICLE

Tags: Sensors, Foreign S&T, S&T China ■

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