Volume 7, Issue 43 ■ 27OCT2017

S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

Feature Articles

Underwater sound waves help scientists locate ocean impacts

Science Daily, 24OCT2017

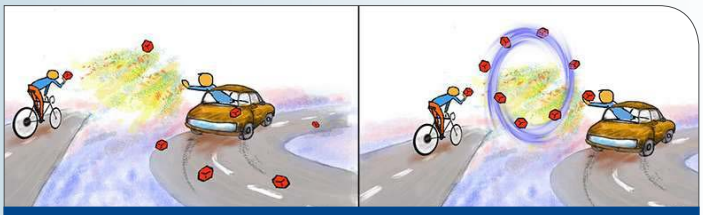
An international team of researchers (UK, USA - MIT, Canada) has developed a method to locate precise time and location of objects that hit the sea surface by employing acoustic–gravity wave theory. In experiments, they found that while the pressure structure is unique to impacting objects, the evolution of the radiated acoustic waves carries information on the source. Results were validated using field observations of recent earthquakes and error below 0.02% for events at relatively large distances of over 1000 km. Besides impacting objects and earthquakes, the method could help in identifying the location of underwater explosions and landslides.

Open Access TECHNICAL ARTICLE

Tags: Sensors, Featured Article

Using optical chaos to control the momentum of light

Physorg.com, 19OCT2017



(Left) Without the chaos, coupling photons to an optical mode is inefficient. (Right) With the chaos, the photons could be efficiently delivered to the optical mode. Credit: Yin Feng and Xuejun Huang

Light needs to be moving at the same momentum to couple it between optical components. An international team of researchers (China, USA - Washington University, Harvard University, Caltech, Germany) has demonstrated a new way to control the momentum of broadband light in a widely-used optical component known as a whispering gallery microcavity. Like the whispering wall, the cavity traps and carries the wave. By deforming the shape of the optical microresonator, the researchers could create and harness chaotic channels. By alternating the shape of the resonator, the momentum can be tuned. The research provides new applications for microcavity optics and photonics in optical quantum processing, optical storage and more. TECHNICAL ARTICLE

Tags: Photonics, Featured Article

S&T News Articles

ADVANCED MANUFACTURING

Bending the laws of thermodynamics for enhanced material design

Nanowerk, 24OCT2017

A team of researchers in the US (NERL, University of Colorado, Oregon State University, SLAC National Accelerator Laboratory, Harvard University) has a new way to create well-mixed semiconductor alloys by combining materials with different crystal structures. They bend the laws of thermodynamics to reduce or eliminate the driving force for such fluctuations. Through a combination of computational calculations and combinatorial thin-film phase-equilibria experiments, they demonstrated that a prototypical alloy ($Mn_{1-x}Zn_xO$) exhibits a dramatically widened window within which binodal decomposition is suppressed and spinodal decomposition is impossible. In this class of alloys, properties (e.g., electronic, optoelectronic, piezoelectric, ferroelectric) can change in a highly non-linear or even discontinuous fashion near the critical composition, providing two new routes to materials design.

Open Access TECHNICAL ARTICLE

Tags: Advanced manufacturing, Advanced materials

Liquid metal discovery ushers in new wave of chemistry and electronics

Science Daily, 19OCT2017

An international team of researchers (Australia, USA - UCLA) used non-toxic alloys of gallium as a reaction medium to cover the surface of a liquid metal with atomically thin oxide layers of the same gallium alloy. The oxide

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layer can then be exfoliated by simply touching the liquid metal with a smooth surface. Larger quantities of these atomically thin layers can be produced by injecting air into the liquid metal. They predict that the developed technology applies to approximately one-third of the periodic table. The work introduces room-temperature liquid metals as a reaction environment for the synthesis of oxide nanomaterials with low dimensionality. It could be applied to enhance data storage and make faster electronics and the technique could be applied to catalysis. TECHNICAL ARTICLE

Tags: Advanced manufacturing, Materials science

ADVANCED MATERIALS

A quantum spin liquid

Science Daily, 24OCT2017

A team of researchers in the US (Boston College, Harvard University) has created copper iridate metal oxide which is capable of frustrating the magnetic properties within it to produce spin liquid. Their studies in x-ray crystallography found subtle flaws in the honeycombs formed in the lithium and sodium iridates. The team swapped copper for sodium. The nearly ideal honeycomb structure places Cu_2IrO_3 closer to a Kitaev spin liquid than its predecessors. TECHNICAL ARTICLE

Tags: Advanced materials

Single nanoparticle mapping paves the way for better nanotechnology

Science Daily, 24OCT2017

An international team of researchers (Denmark, Sweden, Poland, Russia) has developed a method to systematically map the role of grain boundaries in the hydrogenation phase transformation in individual Pd nanoparticles. Their experiments clearly showed how the reaction with hydrogen depends on the specifics of the way in which the nanoparticles are constructed. The results pave the way for better nanomaterials and safer nanotechnology. OPEN ACCESS TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

Turning a pinch of salt into an electrical switch

Nanowerk, 24OCT2017

An international team of researchers (Switzerland, UK, Spain, Sweden) has demonstrated that by stacking two 2D materials, even those that are insulators, we can create new behaviour that neither material would be able to exhibit individually. They started by forming an atomically thin layer of copper nitride on the surface of a copper crystal. On top of this, they deposited an atomically thin layer of sodium chloride and potassium bromide, which do not have net dipoles. Inversion symmetry in the alkali halide layer was broken, inducing out-of-plane dipoles that are stabilized in one orientation. The dipole orientation could be reversed by a critical electric field, producing sharp switching of the tunnel current passing through the junction. TECHNICAL ARTICLE

Tags: Advanced materials

Liquid metal brings soft robotics a step closer

Physorg.com, 17OCT2017

Researchers in the UK have discovered a new class of programmable materials in a liquid state which can dynamically and seamlessly transform from a simple droplet shape to many other complex geometries in a controllable manner by applying electrical charges. The electric fields used to shape the liquid are created by a computer. Their properties include voltage-controlled surface tension, high liquid-state conductivity and liquid-solid phase transition at room temperature. The findings open new possibilities in 'soft robotics' and shape-changing displays. TECHNICAL ARTICLE

Tags: Advanced materials, S&T UK

Researchers make the slipperiest surfaces adhesive

Physorg.com, 17OCT2017

Polytetrafluoroethylene (PTFE), used in Teflon, is one of the slipperiest materials known. However, PTFE is difficult to work with. Researchers in Japan have developed a method combining plasma treatment with extra heating of the PTFE which resulted in PTFE strongly adhering to rubber. The process avoids using harsh chemicals and is simple to implement. OPEN ACCESS TECHNICAL ARTICLE

Tags: Advanced materials, S&T Japan

BIG DATA

Making big data a little smaller

Science Daily, 19OCT2017

Computer scientists have used the Johnson-Lindenstrauss lemma (JL lemma) theorem to reduce the dimensionality of data and help speed up all types of algorithms across many different fields. Researchers at Harvard University have proven that there are 'hard' data sets for which dimensionality reduction beyond what's provided by the JL lemma is impossible. It can act as a preprocessing step, allowing the dimensions of data to be significantly reduced before running algorithms.

Tags: Big data

CYBER SECURITY

Wearables to boost security of voice-based log-in

Science Daily, 17OCT2017

Researchers at the University of Michigan have developed an authentication system called VAuth. It is a wearable device that can take the form of a necklace, ear buds or a small attachment to eyeglasses. VAuth continuously registers speech-induced vibrations on the user's body and pairs them with the sound of that person's voice to create

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"Without scientific progress no amount of achievement in other directions can insure our health, prosperity, and security as a nation in the modern world." VANNEVAR BUSH

a unique and secure signature. The system works by leveraging the instantaneous consistency between signals from the accelerometer in the wearable security token and the microphone in the electronic device. In tests, it achieved 97% detection accuracy and less than 0.1 percent false positive rate, regardless of its position on the body and the user's language, accent or even mobility. The researchers say it also successfully thwarts various practical attacks, such as replay attacks, mangled voice attacks or impersonation attacks. The talk will be presented at an upcoming conference.

Tags: Cyber security

ENVIRONMENTAL SCIENCE

Machine learning used to predict earthquakes in a lab setting

Eurekalert, 22OCT2017

Using a lab-based system that mimics real earthquakes, an international team of researchers (USA - Los Alamos National Laboratory, Boston University, UK) has identified a hidden signal leading up to earthquakes, and used this 'fingerprint' to train a machine learning algorithm to predict future earthquakes. Their results could also be applied to avalanches and landslides. By listening to the acoustic signal emitted, machine learning can predict the time remaining before it fails with great accuracy. According to the researchers, applying this approach to continuous seismic data may lead to significant advances in identifying currently unknown signals, in providing new insights into fault physics, and in placing bounds on fault failure times. OPEN ACCESS TECHNICAL ARTICLE

Tags: Environmental science, Forecasting

IMAGING TECHNOLOGY

3-D mapping of rooms using radar

Physorg.com, 17OCT2017

Researchers in Germany have developed novel signal processing methods for imaging and material characterisation with the aid of radar. They developed an algorithm to reduce the computational cost for converting a radar signal into an informative image. They also eliminated systemic measurement errors from the data. Under controlled lab conditions, their system could determine the position and composition of an object. In the next step, the engineers intend to enable the system to recognise what the object is. Their vision is a flying platform capable of generating a three-dimensional representation of its surroundings. The technology might be useful for finding out what firefighters might encounter behind clouds of smoke in a burning building. More information Marie, (Mobile Material Characterisation and Localisation by Electromagnetic Sensing)

Tags: Imaging technology, Sensors

INFORMATION TECHNOLOGY

World first for reading digitally encoded synthetic molecules

Science Daily, 17OCT2017

In the context of data storage miniaturization, it was recently shown that digital information can be stored in the monomer sequences of non-natural macromolecules. However, the sequencing of such digital polymers is currently limited to short chains. Using mass spectrometry, researchers in France have successfully read several bytes of data recorded on a molecular scale using synthetic polymers. Their work sets a new benchmark for the amount of data, stored as monomers, that may be read using this routine method. It also sets the stage for data storage on a scale 100 times smaller than that of current hard drives. OPEN ACCESS TECHNICAL ARTICLE

Tags: Information technology, S&T France

MATERIALS SCIENCE

Extraordinarily strong nonlinear optical graphene-like material could renovate nonlinear photonics

Physorg.com, 25OCT2017

An international team of researchers (Finland, Canada, USA - University of Arizona, Singapore, Italy, UK) discovered that monolayer molybdenum disulfide has an extremely large nonlinear optical response, which can efficiently convert low-energy photons into coherent high-energy photons. This property can be used for highly miniaturized on-chip photonic devices, such as high-resolution imaging and efficient optical data switching applications. They found that the high-order nonlinear optical processes are stronger than the low-order ones. OPEN ACCESS TECHNICAL ARTICLE 1, 2

Tags: Materials science

Materials with a special kind of boundary between crystal grains can deform in unexpected ways

Physorg.com, 25OCT2017

An international team of researchers (China, USA- Johns Hopkins University, MIT, Singapore) carried out experiments with copper and confirmed coherent twin boundary (CTB) sliding, which was previously considered impossible,

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and its particular driving conditions. The results should apply to some other metals with similar crystal structures, such as gold, silver, and platinum. The findings provide mechanistic insights into the evolution of plasticity in heavily twinned face-centered cubic metals, with the potential for optimizing mechanical properties with nanoscale CTBs in material design. OPEN ACCESS TECHNICAL ARTICLE

Tags: Materials science

FEATURED RESOURCE

Asia Research News

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Designer binders protect silicon battery electrodes

Physorg.com, 20OCT2017

Lithium-ion batteries with silicon anodes have a theoretical capacity 10 times higher than the most commonly used anodes. However, silicon electrodes suffer degradation during charging and discharging. A team of researchers in the US (University of Rhode Island, Brown University) designed binders, small molecules and polymers, as surface-modifying agents and binders for silicon anodes. During cycling, the binders electrochemically reacted and formed a protective layer, which suppressed the decomposition reactions with the electrolyte making the binders more attractive for next-generation lithium-ion batteries and long-range electric vehicles. TECHNICAL ARTICLE 1, 2

Tags: Materials science, Battery, Energy

Turning a material upside-down can sometimes make it softer

Physorg.com, 20OCT2017

The indentation toughness of polar crystals is the result of the interaction between the localised flexoelectric polarisation caused by the mechanical stress gradient of the indentation, along with the piezoelectric polarisation inherent in polar crystals. If the two polarisations run parallel, overall polarisation will be very strong. Researchers in Spain show that if the material is turned over, the flexoelectric effect of the knock will be acting in the opposite direction to the spontaneous piezoelectric effect, making total polarisation weaker and indentation correspondingly easier. These effects were observed not only in the case of forceful indentations and/or perforations, but also for the gentler, non-destructive pressures delivered by the tip of an atomic force microscope. It has applications in smart coatings and reading ferroelectric memories by touch alone. TECHNICAL ARTICLE

Tags: Materials science

Missing link between new topological phases of matter discovered

Physorg.com, 18OCT2017

An international team of researchers (Germany, Austria, Ukraine, Czech Republic) discovered that a transition between two different topological phases can be reversed by an external electric field. They studied crystalline semiconductor films made of a lead, tin and selenium alloy that were doped with tiny amounts of bismuth. They found that the sample changes to a particular topological phase that also exhibits ferroelectricity. Following detailed analyses of the measurements, they concluded that the bismuth doping causes a ferroelectric distortion in the lattice that also changes the allowable energy levels of the electrons. The findings extend the topological phase diagram by a great deal and make strong topological insulators switchable by distortions or electric fields. OPEN ACCESS TECHNICAL ARTICLE

Tags: Materials science

MICROELECTRONICS

Novel 'converter' heralds breakthrough in ultra-fast data processing at nanoscale

Science Daily, 20OCT2017

Researchers in Singapore have invented a converter that can directly convert electrical signals into plasmonic signals, and vice versa, in a single step. Based on lab experiments, the electron-to-plasmon conversion has an efficiency of more than 10 per cent, more than 1,000 times higher than previously reported. By bridging plasmonics and nanoscale electronics, the invention has the potential to make chips run faster and reduce power losses. The plasmonic-electronic transducer is about 10,000 times smaller than optical elements. The researchers believe it can be readily integrated into existing technologies and can potentially be used in a wide range of applications. TECHNICAL ARTICLE

Tags: Microelectronics

Supercomputer simulation of chaotic circuits

Physorg.com, 20OCT2017

An international team of researchers (Poland, Italy) found that even in electronic circuits containing only one or two transistors, chaos is ubiquitous. As chaotic behavior is too complex to build, they decided to discover them. The structure of the circuits made up of commercially available components, was mapped as a sequence of 85 bits. In a gigantic space offering 2^85 possible combinations, they analyzed more or less 2 million circuits. They selected 49 interesting circuits. The smallest chaotic oscillator consisted of one transistor, one capacitor, one resistor and two induction coils. Most of the circuits found showed non-trivial, chaotic behaviour. OPEN ACCESS TECHNICAL ARTICLE

Tags: Microelectronics

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Valley polarization for electronic and optoelectronic technologies clarified

Science Daily, 19OCT2017

Researchers at NRL have uncovered a direct link between sample quality and the degree of valley polarization in monolayer transition metal dichalcogenides (TMDs). In contrast with graphene, many monolayer TMDs are semiconductors and show promise for future applications in electronic and optoelectronic technologies. They found that the TMD monolayers, such as WS2 and WSe2 which have high optical responsivity and samples exhibiting low photoluminescence intensity, exhibited a high degree of valley polarization. These findings suggest a means to engineer valley polarization via controlled introduction of defects and nonradiative recombination sites. According to the researchers, it may be possible to accurately increase polarization by adding defect sites or reduce polarization by passivation of defects. TECHNICAL ARTICLE

Tags: Microelectronics, Government S&T, NRL

NEUROSCIENCE

DARPA Brain Stimulation can accelerate learning by 40%, know why it works, could be common by 2023

Next Big Future, 23OCT2017

An international team of researchers (Canada, USA - industry) has demonstrated that when applied to the prefrontal cortex, transcranial direct current stimulation (tDCS) affects a wide portion of the brain, causing changes in functional connectivity between different brain areas and increases learning speed. Just because neurons can be more brisk in their firing may not lead to changes in performance. Boosting memory function likely requires better coordination of task-relevant information across the cortex. TECHNICAL ARTICLE

Tags: Neuroscience

Artificial Intelligence Learns to Learn Entirely on Its Own

Quanta Magazine, 18OCT2017

Using the program called AlphaGo Zero, researchers in the UK have developed AlphaGo which can achieve unprecedented levels of mastery purely by teaching itself. Starting with zero knowledge of Go strategy and no training by humans, it needed just three days to invent advanced strategies undiscovered by human players. By freeing artificial intelligence from dependence on human knowledge, the breakthrough removes a primary limit on how smart machines can become. It selectively prunes branches by deciding which paths seem most promising based on what it has learned in earlier play about the moves and overall board setups that lead to wins. TECHNICAL ARTICLE

Tags: Neuroscience, Artificial intelligence, Autonomous systems & robotics

PHOTONICS

New type of light interaction with atoms allows for manipulating cloud shape

Physorg.com, 24OCT2017

Researchers in Israel have developed a technique to manipulate atoms with light by firing a pulse of infrared light at a spherical cloud of cold rubidium-87 atoms. The cloud responded by behaving like a lens, deflecting the light and causing the cloud to become longer and thinner—the light beam essentially squished the sphere into a new shape. Because it is a global optical force, the researchers note, it could be easily modified to allow for easy tuning of interactions with lasers. This optomechanical force may effectively induce interparticle interactions, which can be optically tuned. OPEN ACCESS TECHNICAL ARTICLE

Tags: Photonics

Scientists write 'traps' for light with tiny ink droplets

Physorg.com, 23OCT2017

Using a printer based on electrohydrodynamic jets, an international team of researchers (UK, China, France) could deposit ultra-small ink droplets onto photonic crystals. The ink droplets are small enough that they can be 'drawn' on the crystals on demand as if from a very fine pen, and locally change the properties of the crystals so that light could be trapped. This technique enables the creation of many types of patterns onto the photonic crystals, at high speed and over a large area, the patterns can be made of different printable materials. The method is scalable, low-cost, and the photonic crystal is reusable since the ink can be simply washed away. The technique has applications in photonics. OPEN ACCESS TECHNICAL ARTICLE

Tags: Photonics

10 years of the trapped rainbow—the revolution of slow light

Physorg.com, 20OCT2017

In 2007, Professor Ortwin Hess and collaborators published a theoretical paper suggesting that by using metamaterials they could slow light down, and even trap it. Now, 10 years on, they have published a review of how that idea has led to new theories, experiments and applications. In an interview, the professor explains how slow light forms a 'trapped rainbow', and how the potential applications now extend to magnetic storage, lasers, biological imaging and even earthquake shields. TECHNICAL ARTICLE

Tags: Photonics

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Research demonstrates method to alter coherence of light

Science Daily, 18OCT2017

Researchers at Brown University used surface plasmon polaritons as a means to mix the random fluctuations of the incident electromagnetic fields at the slit locations of a Young's double-slit interferometer. Strong tunability of the complex degree of spatial coherence of light was achieved by finely varying the separation distance between the two slits. The technique can modulate coherence across a range from 0 percent (totally incoherent) to 80 percent and vice versa. These findings pave the way for alternative methods to engineer flat optical elements with multifunctional capabilities beyond conventional refractive and diffractive based photonic metasurfaces. Open Access TECHNICAL ARTICLE

Tags: Photonics

Plasma optic combines lasers into superbeam

Physorg.com, 17OCT2017

A team of researchers in the US (Lawrence Livermore National Laboratory, University of Rochester) successfully combined several separate lasers into a superbeam to produce a directed pulse of light that was nearly four times the energy of any of the individual beams. They have demonstrated that it is possible to control optical instabilities in plasma so that rather than randomly scattering energy, they put it where we want it and do so with good collimation and high intensity, producing a bright beam that can be delivered to another target. TECHNICAL ARTICLE

Tags: Photonics

QUANTUM SCIENCE

Nanoelectronics breakthrough could lead to more efficient quantum devices

Science Daily, 18OCT2017

Researchers in Canada have shown experimentally that it is possible to control whether positively and negatively charged particles behave the same way in very short carbon nanotube transistors. In some devices of about 500 atoms long, the positive charges are more confined and act more like particles, while the negative charges are less well confined and act more like waves. The most exciting implications are for building quantum circuits with single devices that can either store or pass quantum information along with the flick of a switch. The discovery could lead to a new generation of two-in-one quantum electronic devices. It could have applications in quantum computing, radiation sensing and transistor electronics. Open Access TECHNICAL ARTICLE

Tags: Quantum science, S&T Canada

Quantum computing—breaking through the 49 qubit simulation barrier

Physorg.com, 18OCT2017

A team of researchers in the US (IBM, New York, Tufts University, University of Illinois at Urbana-Champaign) presents a new approach that significantly extends the boundaries of what can be classically computed. They demonstrated their method by presenting results obtained from a calculation of the complete set of output amplitudes of a universal random circuit with depth 27 in a 2D lattice of 7×7 qubits. The simulations required 4.5 and 3.0 TB of memory, respectively, to store calculations, which is well within the limits of existing classical computers. Open Access TECHNICAL ARTICLE

Tags: Quantum science

S&T POLICY

Smallpox Could Again Be a Serious Threat

Slate.com, 19OCT2017

Synthetic biology, like many other emerging technologies, is dual-use. The most recent dual-use concern about synthetic biology involves one of humanity's oldest foes: smallpox. Smallpox was eradicated from nature in 1980. Researchers in Canada have demonstrated the ability to create horsepox virus by stitching together fragments of synthetic DNA to create an intact viral genome. Although horsepox virus itself is not dangerous, the technology and techniques used to re-create horsepox can also be used construct the closely related smallpox virus. There is no clear international legal or regulatory framework to prevent the synthesis of smallpox virus. Synthetic biology, needs to intensify efforts to raise awareness of these dual-use and biosecurity issues as early as possible in the scientific education process, the private sector needs to be engaged as a partner in safeguarding the bioeconomy and the growing number of biohackers and citizen scientists interested in exploring synthetic biology should be nurtured in safe, secure, and transparent working environments.

Tags: S&T policy, Counter WMD ■

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