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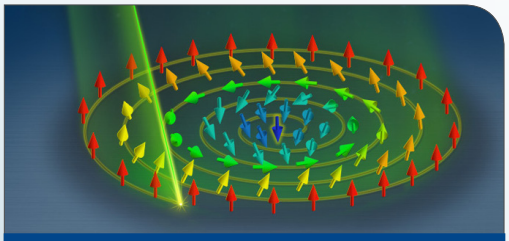
S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

FEATURE ARTICLES

Skyrmions created with a special spiral

Physorg.com, 06APR2017



Argonne researchers have created skyrmions – ordered regions of magnetic spins – by using a spiraling focused ion beam. Credit: Robert Horn / Argonne National Laboratory

A team of researchers in the US (Argonne National Laboratory, Northwestern University) used a focused ion beam to bombard the surface of layers of platinum and cobalt with gallium ions to create skymions. They found that moving the beam in a spiral produced a very nicely defined skyrmion. Starting from the edges and moving towards the center, the inward spiral produced an antiskyrmion. They can make skyrmions and skyrmion-like structures ranging from nanometers to microns. As they are fixed in position, imprinted magnetic spins in the skyrmion can be used to direct electron motion. The research opens new possibilities for exploring new fundamental physics. OPEN ACCESS TECHNICAL ARTICLE

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

Quantum transport goes ballistic

Nanowerk, 05APR2017

Researchers in Switzerland fired electrons from one contact electrode which flew through the nanowire without being scattered until they hit the opposed electrode. The nanowire acts as a perfect guide for electrons, such that the full quantum information of this electron (energy, momentum, spin) can be transferred without losses. They can do this in cross-junctions, which allows them to build up electron pipe networks for quantum information. The technique is scalable and compatible with standard electronics and CMOS processes. TECHNICAL ARTICLE

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

S&T NEWS ARTICLES

ADVANCED MANUFACTURING

A novel method for the fabrication of active-matrix 3-D pressure sensors

Physorg.com, 05APR2017

Researchers in South Korea placed graphene channel, metal nanowire electrodes and an elastic body capable of trapping air on one side of a foldable substrate. They covered the other side of the substrate to trap air. Changes in the thickness of the air-dielectric layer is converted into an electrical signal and transmitted via metal nanowires and the graphene channel, expressing both the position and the intensity of the pressure. The sensor is capable of simultaneously measuring pressure less than 10 kPa to high pressure above 2 MPa. OPEN ACCESS TECHNICAL ARTICLE

Tags: Advanced manufacturing

ADVANCED MATERIALS

New nanocoating for space tech applications

Nanowerk, 06APR2017

An international team of researchers (France, Germany) synthesized $Bi_2Sr_2CaCu_2O_8$ (Bi-2212) superconducting nanowires using a Pb-doped and Cu, Ca-enriched nanowires. The nanowires can be woven into an ultra-thin film that is as flexible as cling film. With a density of 0.05 grams per cubic centimetre, the material is very light, weighing about a hundred times less than a conventional superconductor. Possible applications of the material include aerospace technology, medical technology, coating to provide low-temperature screening from electromagnetic fields and use in flexible cables or to facilitate friction-free motion. TECHNICAL ARTICLE 1, OPEN ACCESS 2, 3, 4

Tags: Advanced materials

Artificial topological matter opens new research directions

Nanowerk, 05APR2017

An international team of researchers (USA - Princeton University, State University of New Jersey, University of

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Central Florida, Lawrence Berkeley National Laboratory, China, Switzerland, Singapore, Germany, UK, France) built a multilayer heterostructure lattice built from alternating thin films of topological and trivial insulators. Each interface hosts a set of topologically protected interface states and causes hybridization of interface states across layers. The heterostructure forms an emergent atomic chain, where the interfaces act as lattice sites and the interface states act as atomic orbitals. By changing the composition of the heterostructure, hopping between lattice sites can be controlled. The research could lead to circuits based on topological behaviors and artificial crystal lattice structure for studying quantum behaviors. Open Access TECHNICAL ARTICLE

Tags: Advanced materials

Donut-shaped nanomagnets induce new magnetization states

Nanotechweb, 04APR2017

An international team of researchers (Chile, Brazil) designed and modelled a nanomagnet in the shape of a torus, which has negative curvature on the internal border and positive on the external border. They exposed this to an external magnetizing field in the plane of the torus and monitored the remnant magnetization left behind after this field was removed. At each of these borders a stable vortex or antivortex was formed according to the direction of the curvature. The ability to manipulate magnetization vortex–antivortex pairs opens a number of potential applications in computing and data storage which could exceed the fundamental limit of current devices. Open Access TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

Researchers "iron out" graphene's wrinkles

MIT News, 03APR2017

The CVD process for producing graphene can result in relatively large, macroscopic wrinkles, due to the roughness of the underlying copper and the process of pulling the graphene out from the acid, that significantly limits graphene's electrical performance. Researchers at MIT produced single-crystalline graphene from a silicon carbide wafer with an atomically smooth surface and step-like wrinkles on the order of several nanometers. Using a thin sheet of nickel, the topmost graphene was peeled off from the silicon carbide wafer. They found the mobility in ironed graphene to be two times faster and its electrical quality much higher. TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

AUTONOMOUS SYSTEMS & ROBOTICS

Robotics, Smart Materials, and Their Future Impact for Humans

MIT Technology Review, 06APR2017

Instead of a conventional robot which can be decomposed into mechanical, electrical, and computational domains, we can think of a robot in terms of its biological counterpart and having three core components: a body, a brain, and a stomach. The benefit of this artificial organism paradigm is that we are encouraged to exploit, and go beyond, all the characteristics of biological organisms. And the realization of this goal is only achievable by concerted research in the areas of smart materials, synthetic biology, artificial intelligence, and adaptation. Full article

Tags: Autonomous systems & robotics, Artificial intelligence

BIG DATA

DARPA Wades into Murky Multimedia Information Streams to Catch Big Meaning

DARPA News, 06APR2017

DARPA seeks to overcome the noisy, conflicting, and potentially intentionally deceptive nature of today's data environment through a program called Active Interpretation of Disparate Alternatives (AIDA). The goal of AIDA is to develop a multi-hypothesis "semantic engine" that generates explicit alternative interpretations or meaning of real-world events, situations, and trends based on data obtained from an expansive range of outlets. BAA

Tags: Big data

COUNTER WMD

DTRA Seeks Laboratory Services for WMD Stand-Off Detection Testing

Global Biodefense, 05APR2017

DTRA is seeking potential sources for chemical and biological counter-weapons of mass destruction laboratory analysis services. Technologies should be able to measure airborne chemical concentrations, determine vapor and aerosol fractions, and characterize aerosol composition, size distribution, concentration and velocities for agent defeat tests. Required tasks include establishing and verifying suitable point referee systems for future stand-off technology readiness assessment and detection and analysis of biological simulants. BAA

Tags: Counter WMD

ENERGY

Hybrid perovskite material could replace silicon to double efficiency of solar cells

Nanowerk, 06APR2017

A team of researchers in the US (Purdue University, National Renewable Energy Laboratory) has demonstrated that hot carriers in a standard polycrystalline perovskite thin film can travel over 200 nanometers with minimal energy loss to heat and live for about 100 picoseconds, two orders of magnitude longer than silicon. These results suggest potential applications of hot-carrier devices based on hybrid perovskites. TECHNICAL ARTICLE

Tags: Energy, Advanced materials

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"Discovery consists of seeing what everybody has seen and thinking what nobody has thought." ALBERT SZENT-GYÖRGYI

ENVIRONMENTAL SCIENCE

Global surface temperature trends and the effect of World War II

ArXiv, 27MAR2017

Using parametric analysis, researchers at Harvard University found a persistent temperature bump, coincident with World War II in eight independent time series, four land- and four ocean-based. Six parameters (constant, linear and quadratic background terms and the amplitude, position and width of the Gaussian) are free to vary. They fit the data with a Gaussian on a quadratic background. Rather than coincidence, or systematic measuring error synchronized with WW2, they conjecture the bump is due to human activity, including the greatly increased combustion (relative to that era) of fossil and other fuels. Background surface temperature behavior is far more consequential nowadays. OPEN ACCESS TECHNICAL ARTICLE

Tags: Environmental science, Climatology

INFORMATION TECHNOLOGY

Smallest Dutch supercomputer

Physorg.com, 06APR2017

Researchers in the Netherlands have built a supercomputer the size of four pizza boxes, called the Little Green Machine II. It was constructed from four servers with four special graphics cards each, connected via a high-speed network. It has a computing power of more than 0.2 Petaflops. The supercomputer equals the computing power of more than 10,000 ordinary PCs. It is easily transportable and uses about 1% of the electricity of a similar large supercomputer. To test the supercomputer, the researchers simulated the collision between the Milky Way and the Andromeda Galaxy. It can be used by researchers in oceanography, computer science, artificial intelligence, financial modeling and astronomy.

Tags: Information technology

MATERIALS SCIENCE

Turning back time: Watching rust transform into iron

Nanowerk, 05APR2017

Iron oxides play a leading role in magnetic data storage, cosmetics, the pigmentation of paints and drug delivery. A team of researchers in the US (State University of New York at Binghamton, NIST, University of Maryland) has developed a technique to provide detailed atomic-level understanding of reduction (opposite of rusting) to enable fine tuning of these minerals for various applications. They slowed down the reduction process in a bicrystal of iron oxide and identified a previously unknown intermediate state in the transformation from magnetite to hematite. In the middle stage, the iron oxide retained its original chemical structure but changed the crystallographic arrangement of its atoms. The intermediate state featured defects which occurred in an ordered pattern which may be important for controlling the reduction rate and other properties of the reduction process. TECHNICAL ARTICLE

Tags: Materials science

Nanoscopic golden springs change color of twisted light

Science Daily, 03APR2017

Minuscule gold springs can be helpful in studying small amounts of chiral molecules. An international team of researchers (UK, Germany) examined how effective the gold springs could be at enhancing interactions between light and chiral molecules based on second harmonic generation, whereby the better the performance of the spring, the more red laser light converts into blue laser light. They found that the springs were very promising but their performance depended on the direction they were facing. The technique has applications in pharmaceutical design, telecommunications and nanorobotics. OPEN ACCESS TECHNICAL ARTICLE

Tags: Materials science, Advanced materials

Research looks at friction properties of material

Physorg.com, 23MAR2017

A team of researchers in the US (Sandia National Laboratory, Virginia Polytechnic Institute) has established a correlation between the macro-scale friction regimes of metals and a transition between two dominant atomistic mechanisms of deformation. Metals tend to exhibit bi-stable friction behavior—low and converging or high and diverging. These general trends in behavior are shown to be largely explained using a simplified model based on grain size evolution, as a function of contact stress and temperature, and are demonstrated for self-mated pure copper and gold sliding contacts. The model they have developed could impact electrical contacts, wind turbines and pave the way for new materials designs. TECHNICAL ARTICLE

Tags: Materials science, Government S&T

MICROELECTRONICS

Putting a spin on logic gates

Science Daily, 10APR2017

An international team of researchers (Germany, Belgium) used vibrations in an Yttrium-Iron-Garnet-based waveguiding structure to build a majority gate. This logic device features a three-input combiner with the logic information encoded in a phase of 0 or π of the input spin waves.

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They show that the phase of the output signal represents the majority of the three phase states of the spin waves in the three inputs. A switching time of about 10 ns in the prototype device provides evidence for the ability of sub-nanosecond data processing in future down-scaled devices. Open Access TECHNICAL ARTICLE

Tags: Microelectronics, Information technology

Researchers see inside integrated circuits at high resolution

Nanotechweb, 06APR2017

Current methods for seeing inside ICs for quality control and product development are laborious and destructive. Researchers in Switzerland used coherent X-ray beams that penetrate the sample and produce a diffraction pattern. Combining several hundred such patterns, the team has managed to achieve non-destructive imaging of the internal structure of an IC with excellent 3D resolution. With further development of X-ray sources and optics, this promises to be a transformative technology for the analysis and quality control of integrated circuits. TECHNICAL ARTICLE

Tags: Microelectronics, S&T Switzerland

Featured Resource

IEEE Spectrum Reports, Resources and more

Blogs, podcasts, news and features stories, videos and interactive infographics with clear and detailed explanations about emerging concepts and developments.

Carbon nanotubes self-assemble into tiny transistors

Science Daily, 05APR2017

An international team of researchers (the Netherlands, Germany, Switzerland) functionalized polyfluorene derivatives with side chains containing thiols to obtain chemical self-assembly of the selected s-SWNTs on substrates with prepatterned gold electrodes. SWNT devices based on individual tubes show an unprecedented (100%) yield for working devices. The SWNTs are stably anchored to the substrate and are resistant to external perturbation as sonication in organic solvents. They have created a library of polymers that select semiconducting nanotubes and developed a better understanding of how the structure and composition of the polymers influences the selection of carbon nanotubes. Carbon nanotubes can be used to make very small electronic devices. TECHNICAL ARTICLE

Tags: Microelectronics, Advanced materials

NEUROSCIENCE

Electronic nanosynapses could make artificial brains

Nanotechweb, 06APR2017

An international team of researchers (France, USA - University of Arkansas) has created a memristor based on ferroelectric tunnel junctions that can autonomously learn to recognize patterns. They have also succeeded in modelling the synapse's plasticity by looking at how its resistance varies with varying applied voltage. Building a crossbar array of ferroelectric memristors connected to CMOS-based neurons shows that the systems can indeed learn unsupervised and recognize patterns. Open Access TECHNICAL ARTICLE

Tags: Neuroscience, Artificial intelligence

PHOTONICS

Device boosts interaction between light and motion

Eurekalert, 06APR2017

The use of optomechanical devices to study macroscopic quantum phenomena requires extremely high levels of coupling between light waves and mechanical waves. Researchers in Brazil have created a device based on a 24-micron silicon disk supported by a silicon dioxide central pedestal that can vibrate, and has concentric circular grooves. Light waves are compressed near the disk edge and mechanical vibrations can propagate them throughout the material. The concentric rings create frequency regions in which mechanical waves cannot propagate. The confinement boosts light and mechanical interaction. The technique has potential application as optical modulators in telecommunications. Open Access TECHNICAL ARTICLE

Tags: Photonics

QUANTUM SCIENCE

A Milestone for Quantum Computing

MIT Technology Review, 11APR2017

The ability to simulate near-term quantum computers using classical computers is crucial for calibration, validation, and benchmarking. Researchers in Switzerland use automatic code generation and optimization of compute kernels. They applied a scheduling algorithm to quantum supremacy circuits to reduce the required communication and simulate a 45-qubit circuit on the Cori II supercomputer using 8,192 nodes and 0.5 petabytes of memory. The highly-tuned kernels, in combination with the reduced communication requirements, allow an improvement in time-to-solution over state-of-the-art simulators by more than an order of magnitude at every scale. Open Access TECHNICAL ARTICLE

Tags: Quantum science, S&T Switzerland

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Bell correlations measured in 500,000 atoms

Physics World, 07APR2017

Researchers at Stanford University have measured strong Bell correlations in an ensemble of 500,000 cold rubidium-87 atoms that are trapped by laser light. The atoms are put into an entangled state using spin squeezing. As dictated by the uncertainty principle, reducing the uncertainty of the z-component increases the uncertainty of the x-component. The spin-squeezed states have immediate applications in improving the precision of atomic clocks and atom interferometers. TECHNICAL ARTICLE

Tags: Quantum science

Quantum-physical model system

Science Daily, 06APR2017

Observing quantum-physical phenomena, isolating it from the environment, is never possible. An international team of researchers (Germany, Italy) has developed a model system that enables a better understanding of the processes with ultracold atoms. They confined ultracold atoms in a chain of potential wells. They emptied the middle well and watched it refill with atoms from other wells. The results of this study suggest that decoherence, i.e. external interference, plays a critical role in this process. What is unclear is which microscopic processes the quantum system uses to interact with the environment. Findings help ensure the coherence of the system and selectively effect special conditions. TECHNICAL ARTICLE

Tags: Quantum science

Quantum Computing Now Has a Powerful Search Tool

MIT Technology Review, 05APR2017

A team of researchers in the US (University of Maryland, NSF, industry partner) performed a three-qubit Grover search algorithm using scalable quantum computing technology on a quantum computer consisting of a string of five ytterbium ions suspended in an electromagnetic field. The algorithm is performed for all 8 possible single-result oracles and all 28 possible two-result oracles. All quantum solutions are shown to outperform their classical counterparts. This paves the way for more extensive use of the Grover search algorithm in solving larger problems on quantum computers, including using the circuit as a subroutine for other quantum algorithms. OPEN ACCESS TECHNICAL ARTICLE

Tags: Quantum science

Computing—quantum deep

Physorg.com, 03APR2017

A team of researchers in the US (Oak Ridge National Laboratory, University of Southern California, University of Tennessee) is bringing together quantum, high-performance and neuromorphic computing architectures to address complex issues that, if resolved, could clear the way for more flexible, efficient technologies in intelligent computing. They used the MNIST dataset to show that a quantum computer can find high quality values of intra-layer connections weights, in a tractable time as the complexity of the network increases; a high-performance computer can find optimal layer-based topologies; and a neuromorphic computer can represent the complex topology and weights derived from the other architectures in low power memristive hardware. OPEN ACCESS TECHNICAL ARTICLE

Tags: Quantum science, Government S&T

S&T POLICY

TTO 2017 Virtual Proposers Day Seeks Revolutionary Technology Concepts to Transform Future Military Capabilities

DARPA News, 11APR2017

The Virtual Proposers Day will be held on Wednesday, May 3–Thursday, May 4, 2017. In a forthcoming 2017 Innovative Systems for Military Missions BAA (HR001117S0014), DARPA will seek responses in these areas: Ground Systems, Maritime/Undersea Systems, Air Systems, Space Systems and Cross-Domain Systems. More information

Tags: S&T policy

A chip-sized ultra-resolution microscope

Nanowerk, 06APR2017

ChipScope is an EU sponsored project whose objective is to develop the necessary science and technology to see extremely small structures such as viruses, DNA molecules or the inside of cells, in real time and without the disadvantages of the current high resolution techniques. The project is led by Spain, and includes universities from Germany, Austria and Switzerland. They have a 375 million euros funding for 4 years.

Tags: S&T policy, Imaging technology, S&T EU

Can we use solar energy to make fertilizer right on the farm?

Physorg.com, 05APR2017

An international team of researchers (UK, Denmark, France, Germany, Belgium, Bulgaria, Switzerland) is working to develop a solar-powered chemistry technology that can make fertilizer right on the farm and apply it directly to crops, drip-irrigation style. The idea is to replace the centralized, fossil-fuel based Haber-Bosch process with a distributed network of ammonia-on-demand production modules run off renewable energy. These modules would use solar power to pull nitrogen from the atmosphere and catalyze the splitting of water molecules to get hydrogen and oxygen. The catalytic processes would then unite one nitrogen atom to three hydrogen atoms to produce ammonia, with oxygen as a waste product. Some of the challenges include designing catalysts that can make and break bonds

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with atomic precision, durable, simple to use and cost effective to mass produce. Open Access TECHNICAL ARTICLE

Tags: S&T policy

SCIENCE WITHOUT BORDERS

Physicists discover hidden aspects of electrodynamics

Science Daily, 11APR2017

According to Maxwell's theory, electric-magnetic duality remains unaltered under the interchange of the electric and magnetic fields when charges and currents are not present. Gravity, together with quantum effects, disrupts the electric-magnetic duality or symmetry of the electro-magnetic field. An international team of researchers (USA - Louisiana State University, Spain) has been able to write the theory and prove this absence of symmetry by using powerful techniques that were developed for fermions. Since this new finding suggests that the symmetry does not exist at the fundamental level, the polarization of the Cosmic Microwave Background can change throughout cosmic evolution. TECHNICAL ARTICLE

Tags: Science without borders

SENSORS

Glowing bacteria detect buried landmines

Eurekalert, 11APR2017

All landmines leak minute quantities of explosive vapors, which accumulate in the soil above them and serve as markers for their presence. Researchers in Israel engineered live bacteria that emit fluorescent signal when they come in contact with these vapors. The bacteria were encapsulated in small polymeric beads, which were scattered across a test field in which real antipersonnel landmines were buried. Using a laser-based scanning system, the test field was remotely scanned and determined the locations of the buried landmines. A signal can be recorded and quantified from a remote location. The research could pave the way for developing an operational device for stand-off detection of landmines.

Tags: Sensors

Green laser light probes metals for hidden damage

Physorg.com, 05APR2017

X-ray imaging used for non-destructive testing (NDT) of metals is expensive and hard to adapt for use in the field. Researchers at Brigham Young University have developed a new technique for NDT using second harmonic generation (SHG) which alters the wavelength of light. It involves shining green laser light onto a metal sample. Through SHG, the metal converts some of the incoming light into ultraviolet light, which bounces back from the metal along with the remaining green light. The amount of conversion depends on the properties of the metal, and if those properties have changed due to some form of stress, it can be detected in the converted light. In tests, the technique could distinguish between damaged and undamaged parts. The team is working to develop a portable system. They presented their invention at a recent American Chemical Society meeting.

Tags: Sensors, Photonics ■

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