



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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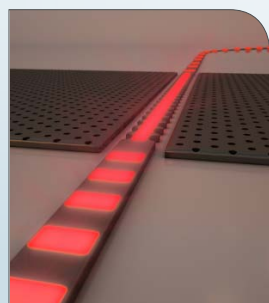
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## FEATURE ARTICLES

### [A zero-index waveguide: Researchers directly observe infinitely long wavelengths for the first time](#)

[Physorg.com, 09OCT2017](#)



*A zero-index waveguide compatible with current silicon photonic technologies. Credit: Second Bay Studios/Harvard SEAS*

Researchers at Harvard University “pinned-down” light by shining beams in opposite directions through a device to create a standing wave. Because of the zero-index material, the team could stretch the wavelength large enough to see. The waveguide is compatible with current silicon photonic technologies, which adds an important tool to the silicon photonics toolbox. They can be

directly plugged into conventional optical devices, and find real uses for zero-index phenomena. In the future, quantum computers may be based on networks of excited atoms that communicate via photons. The interaction range of the atoms is roughly equal to the wavelength of light.

*Tags: Photonics, Featured Article*

### [Why Do So Many Americans Win the Nobel Prize?](#)

[Inside Science, 06OCT2017](#)

In response to a question from a reporter, the secretary general of the Royal Swedish Academy of Sciences said, the primary reasons why so many Americans win the Nobel Prize, are funding and academic freedom. Since the mid-20th century, the United States has spent a tremendous amount on fundamental or “basic” research, not forcing scientists to work on projects with an immediate application as the goal. Experts in science funding agreed that the overabundance of American Nobel Prize winners is no coincidence. Basic science is where the biggest long-term breakthroughs come from, and Nobel Prizes tend to recognize those breakthroughs. At the end

of the war, Vannevar Bush prepared a report to the president that placed a strong emphasis on basic research. He adopted the position that it was the government’s responsibility to do basic research through the universities. That model became enshrined in the U.S. approach to financing science after the war, one fruit of which is the overabundance of Nobel Prizes for researchers at American universities. Related report: [Science the Endless Frontier](#).

*Tags: S&T policy, Science without borders, Featured Article*

## S&T NEWS ARTICLES

### ADVANCED MATERIALS

#### [Asymmetric sound absorption lets in the light](#)

[Science Daily, 06OCT2017](#)

Researchers in China have developed a mechanism for the asymmetric absorption of acoustic waves in a two-port transparent waveguide system by shunting detuned Helmholtz resonators pairs in cascade. They developed and demonstrated a methodology to induce non-reciprocal absorption and reflectance for both multiband and broadband sound. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Foreign S&T, S&T China*

#### [What can be discovered at the junction of physics and chemistry?](#)

[Nanowerk, 06OCT2017](#)

An international team of researchers (Russia, Finland, Norway) has discovered a new type of rare paramagnetic molecules from the class porphyrins. Unlike other molecules with similar structures, porphyrins are unchanged even in the air around us. This makes it possible to manipulate their physicochemical properties with an external magnetic field in various applied fields of magneto-optics and nanotechnology. Porphyrins are part of hemoglobin and chlorophyll and are closely related to the processes of photosynthesis and respiration in living organisms. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Materials science*

*continued...*

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## AUTONOMOUS SYSTEMS &amp; ROBOTICS

**The Seven Deadly Sins of AI Predictions**[MIT Technology Review, 06OCT2017](#)

According to Rodney Brooks, mistaken predictions lead to fears of things that are not going to happen, whether it is the wide-scale destruction of jobs, the Singularity, or the advent of AI that has values different from ours and might try to destroy us. We need to push back on these mistakes. But why are people making them? Seven common reasons he cites include overestimating and underestimating, imagining magic, performance versus competence, suitcase words, exponentials, Hollywood scenarios and speed of deployment.

*Tags: Autonomous systems & robotics, Artificial intelligence*

**Is AI Riding a One-Trick Pony?**[MIT Technology Review, 29SEP2017](#)

AI today is deep learning, and deep learning is backpropagation (backprop)—which is amazing, considering that backprop is more than 30 years old. It's worth understanding how that happened—how a technique could lie in wait for so long and then cause such an explosion—because once you understand the story of backprop, you'll start to understand the current moment in AI, and the fact that maybe we're not actually at the beginning of a revolution. Maybe we're at the end of one. What is it about the human brain that makes it learn so well? Will a computer ever be able to learn so quickly and so fluidly?

*Tags: Autonomous systems & robotics, Artificial intelligence*

## BIOTECHNOLOGY

**Bacteria with synthetic gene circuit self-assemble to build working device with gold nanoparticles**[Physorg.com, 09OCT2017](#)

A team of researchers in the US (Duke University, Michigan State University) has demonstrated programmable fabrication of a three-dimensional composite structure by printing engineered self-patterning bacteria on permeable membranes that serve as a structural scaffold. The cells themselves were programmed and their access to nutrients was controlled, but still left the bacteria free to grow in three dimensions. The size and shape properties of the dome could be altered by controlling the properties of the porous membrane it grows on. They developed pressure sensors using this process. According to the researchers, the technique could have applications in biologically responsive materials, self-healing materials and materials that respond to environmental changes.

**TECHNICAL ARTICLE**

*Tags: Biotechnology*

**China sprints ahead in CRISPR therapy race**[Science magazine, 06OCT2017](#)

Researchers in China are speeding toward potential CRISPR applications in humans. The most striking evidence of progress in China can be found on the [clinical trial database](#). Of the 10 listed trials of CRISPR in patients, nine are in China, where streamlined safety and ethical reviews have given researchers a head start. Three of the groups confirmed to Science that they are infusing cancer patients with their own immune cells modified using CRISPR.

*Tags: Biotechnology, Foreign S&T, S&T China, S&T Policy, Synthetic biology*

**Smart bandage could promote better, faster healing**[Physorg.com, 05OCT2017](#)

A team of researchers in the US (Harvard Medical School, MIT, Harvard University, Tufts University) has developed a bandage that consists of electrically conductive fibers coated with a gel that can be individually loaded with infection-fighting antibiotics, tissue-regenerating growth factors, painkillers or other medications. A microcontroller no larger than a postage stamp, which could be triggered by a smartphone or other wireless devices, sends small amounts of voltage through a chosen fiber; the voltage heats the fiber and hydrogel, releasing its cargo. A single bandage could accommodate multiple medications tailored to a specific type of wound while offering the ability to precisely control the dose and delivery schedule of those medications. The bandage was successfully tested on mice. **TECHNICAL ARTICLE**

*Tags: Biotechnology, Medical technology*

## COMMUNICATIONS TECHNOLOGY

**Engineers invent breakthrough millimeter-wave circulator IC (w/video)**[Science Daily, 06OCT2017](#)

Traditionally, nonreciprocal devices have been built from special magnetic materials that make them bulky, expensive, and not suitable for consumer wireless electronics. A team of researchers in the US (Columbia University, UT Austin) has developed a new way to enable nonreciprocal transmission of waves using carefully synchronized high-speed transistor switches that route forward and reverse waves differently. The approach enables circulators to be built in conventional semiconductor chips and operate at millimeter-wave frequencies, enabling full-duplex or two-way wireless which doubles data capacity within existing bandwidth. Going to the higher mm-wave frequencies, 30GHz and above, opens new bandwidth that is not currently in use. Their long-term goal is to build a large-scale mm-wave full-duplex phased array system that uses their circulator. **OPEN ACCESS TECHNICAL ARTICLE**

*Tags: Communications technology*



“Basic research leads to new knowledge. It provides scientific capital. Today, it is truer than ever that basic research is the pacemaker of technological progress.” VANNEVAR BUSH

## ENERGY

### **Huge energy potential in open ocean wind farms in the North Atlantic**

Science Daily, 10OCT2017

The rate of electricity generation in large wind farms containing multiple wind arrays is constrained by the rate of kinetic energy replenishment from the atmosphere above. Researchers at Carnegie Institution for Science show that considerably higher power generation rates may be sustainable over the North Atlantic where the downward transport of kinetic energy may sustain extraction rates of  $6 \text{ W m}^{-2}$  and above over large areas in the annual mean. While no commercial-scale deep water wind farms yet exist, the research results suggest that such technologies, if they became technically and economically feasible, could potentially provide civilization-scale power. [OPEN ACCESS](#)

TECHNICAL ARTICLE

Tags: Energy, Wind energy

### **Solar energy: Prototype shows how tiny photodetectors can double their efficiency**

Science Daily, 09OCT2017

Researchers at UC Riverside developed a photodetector by stacking two atomic layers of tungsten diselenide ( $\text{WSe}_2$ ) on a single atomic layer of molybdenum diselenide ( $\text{MoSe}_2$ ). They observed that when a photon strikes the  $\text{WSe}_2$  layer, it knocks loose an electron, freeing it to conduct through the  $\text{WSe}_2$ . At the junction between  $\text{WSe}_2$  and  $\text{MoSe}_2$ , the electron drops down into  $\text{MoSe}_2$ . The energy given off then catapults a second electron from the  $\text{WSe}_2$  into the  $\text{MoSe}_2$ , where both electrons become free to move and generate electricity. More electrons could be generated also by increasing the temperature of the device. As these materials are nearly transparent and flexible, they could be included in paint, solar cells and wearable photovoltaics. [TECHNICAL ARTICLE](#)

Tags: Energy, Advanced materials, Solar energy

### **Electron behavior under extreme conditions described for the first time**

Science Daily, 06OCT2017

By means of accurate simulations, an international team of researchers (Germany, UK, USA - Lawrence Livermore National Laboratory) has modeled the actions of electrons under extreme temperatures and densities such as those found within planets and stars. Description of the thermodynamic properties of interacting electrons in the range of warm dense matter is relevant for experiments with inertial confinement fusion, where fuel pellets are put under

extreme pressure. This can cause chain reactions that could provide a virtually unlimited source of clean energy.

TECHNICAL ARTICLE

Tags: Energy, Particle physics

## ENVIRONMENTAL SCIENCE

### **Climate solution in soil?**

Science Daily, 05OCT2017

Soil organic matter (SOM) anchors global terrestrial productivity and food and fiber supply. It retains water and soil nutrients and stores more global carbon than do plants and the atmosphere combined. SOM is also decomposed by microbes returning  $\text{CO}_2$  to the atmosphere. According to an international team of researchers (USA - Stanford University, Oregon State University, University of Hawaii, Sweden, Canada, Buenos Aires, Uruguay) soil carbon stocks have been widely lost or degraded through land use changes and unsustainable forest and agricultural practices. Managed well, soil's ability to trap carbon dioxide is potentially much greater than previously estimated, and the resource could "significantly" offset increasing global emissions. More research is needed to unlock soil's potential to mitigate global warming, improve crop yields and increase resilience, say the researchers.

[OPEN ACCESS](#) TECHNICAL ARTICLE

Tags: Environmental science, Climatology

### **The stalling: global wind speeds slowing since 1960**

EU Research and Innovation, 05OCT2017

Wind speeds around the world seem to be decreasing in a phenomenon known as 'stalling'. It is a phenomenon occurring on a different scale, as the average global wind speed close to the surface of the land decreases. While it is not affecting the whole earth evenly, the average terrestrial wind speed has decreased by 0.5 kilometres per hour (0.3 miles per hour) every decade, according to data starting in the 1960s. A declining trend in wind speed can impact agriculture, hydrology, long-term power generation, less dispersion of pollutants in big cities, exacerbating air quality problems and therefore impacting human health. Researchers in the EU are attempting to unravel whether stalling is a recent phenomenon due to human-driven climate change or if it occurred in the past as part of larger climate cycles.

Tags: Environmental science, Climatology, S&T EU

## IMAGING TECHNOLOGY

**[An algorithm for your blind spot](#)**

MIT News, 09OCT2017

A team of researchers in the US (MIT, industry partner) has developed an imaging system, called "CornerCameras", which can work with smartphone cameras and use information about light reflections to detect objects or people in a hidden scene in real-time. Using video of the penumbra and observing the scene over several seconds and stitching together dozens of distinct images, the system can distinguish distinct objects in motion and determine their speed and trajectory. It does not require actively projecting light into the space, and works in a wider range of indoor and outdoor environments and with off-the-shelf consumer cameras. In tests, the CornerCameras worked in a range of challenging situations, including weather conditions like rain. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Imaging technology*

## 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](#).

## MATERIALS SCIENCE

**[Exotic quantum particle observed in bilayer graphene](#)**

Science Daily, 06OCT2017

Fractional quantum Hall effect (FQHE) encompasses some of the most perplexing concepts in modern condensed matter physics, such as quasi-particle formation, quantization, and even superconductivity. An international team of researchers (Columbia University, Japan) has observed that in bilayer graphene, the FQH state survives to much higher temperatures than previously thought possible. It permits the study of this phenomenon in new ways. The findings confirm that, by fabricating a material system with just the right thickness and just the right number of electrons, and then applying just the right magnetic fields, we could effectively engineer fundamentally new classes of particles, with properties that do not otherwise exist among known particles naturally found in the universe. [TECHNICAL ARTICLE](#) (Tags: *Materials science, Advanced materials*)

## MICROELECTRONICS

**[Memristor-Driven Analog Compute Engine Would Use Chaos to Compute Efficiently](#)**

IEEE Spectrum, 09OCT2017

The edge of chaos state allows for fast, efficient analog computation of the kind that can solve problems that grow vastly more difficult as they become bigger in size. Researchers at Hewlett Packard made a Mott memristor from an 8-nanometer-thick layer of niobium dioxide (NbO<sub>2</sub>) sandwiched between two layers of titanium nitride. They showed that this type of memristor can generate chaotic and nonchaotic signals. By controlling voltage and current, the device could be put into a state where random thermal fluctuations in NbO<sub>2</sub> are amplified enough to alter the way the memristor reacts. In simulations, they integrated an array of Mott memristors with a common type memristor made of titanium oxide to form a Hopfield network. These networks are particularly good at solving optimization problems. According to the researchers, the "analog compute engines" could be embedded in systems-on-a-chip to accelerate optimization problems.

Tags: *Microelectronics, Information technology*

## PHOTONICS

**[A particle accelerator on a microchip](#)**

Nanowerk, 10OCT2017

An international team of researchers (Germany, Czech Republic) has developed a new technique using the intersection of two laser beams oscillating at different frequencies to generate an optical field whose properties the researchers can influence to an extremely precise degree. The optical field retains contact with the electrons, transmits its properties exactly to the particles and accelerates them. The acceleration gradient reaches the extremely high value of 2.2 giga-electron-volts per metre, much higher than that attained by conventional accelerators. However, the acceleration distance of only 0.01 millimetres is not sufficient for them to generate the energy needed for achieving results of relevance to practical applications. This approach will hopefully enable us to make this innovative particle acceleration technique usable in a range of research areas and fields of application such as materials science, biology and medicine. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Photonics, Particle physics***[Single 'solitons' promising for optical technologies](#)**

Physorg.com, 09OCT2017

Soliton mode-locking in microresonators usually leads to multi-soliton combs with a structured spectrum. The smooth spectrum of a single soliton is favored for applications. An international team of researchers (USA - Northwestern University, Purdue University, Italy) demonstrated that the soliton number is reduced to one to lower the nonlinear



loss into mode-interaction induced Cherenkov radiation (CR). The research could bring a host of applications, from miniature optical sensors to high-precision spectroscopy and optical communications systems that transmit greater volumes of information with better quality. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Photonics, Communications technology*

### [A dash of gold improves microlasers](#)

[Science Daily, 06OCT2017](#)

Industrial combs are generated using large systems requiring watts of input power. To create smaller systems that could enable residential or portable applications, researchers at the Southern California University have demonstrated frequency combs requiring only milliwatts of input power by attaching gold nanorods to the surface of a single microlaser. Gold nanorods increase the intensity of the light circulating in the device allowing for the comb generation to begin at a much lower power. Polymer coating on the nanoparticles further improved wavelength generation. The technique has applications in developing a portable chemical spectroscopy system. [TECHNICAL ARTICLE](#)

*Tags: Photonics, Sensors*

### [How close to invisible can a mirror be?](#)

[Physorg.com, 06OCT2017](#)

In 2011 researchers proved that objects with mirror surfaces cannot be perfectly invisible. Now researchers in Portugal have shown that the visibility index, determined by the angles at which light rays deviate when they reach an object, can never be smaller than a certain positive value that is a function of the object's volume and the radius of an invisible sphere that contains the object. The ability to create the effect of invisibility—especially when viewed from multiple directions—has a wide variety of potential uses, including military applications (hiding submarines and aircraft), medical imaging (cloaking internal organs that are blocking an area of interest), and improving the performance of small-scale electronics devices by carefully controlling the flow of light and heat. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Photonics, Foreign S&T, Sensors*

## QUANTUM SCIENCE

### [Energy against the current on a quantum scale, without contradicting the laws of physics](#)

[Science Daily, 06OCT2017](#)

An international team of researchers (Spain, Germany) has demonstrated that in a standard thermo-electric nanodevice, the current and heat flows are not only dictated by the temperature and potential gradient, but also by the external action of a local quantum observer that controls the coherence of the device. Depending on how and where the observation takes place, the direction of heat and particle currents can be independently controlled. They

have shown that the current and heat flow in a quantum material can go against the natural temperature and voltage gradients. This scheme provides novel strategies to construct quantum devices with application in thermoelectrics, spintronic injection, phononics, and sensing among others. They believe the applications are a long way off because of limitations in the design of the observers. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Quantum science*

## S&T POLICY

### [China will open a \\$10 billion quantum computer center and others also investing in quantum computing](#)

[Next Big Future, 10OCT2017](#)

The National Laboratory for Quantum Information Sciences, slated to open in 2020, has two major research goals: quantum metrology and building a quantum computer. Both efforts would support military and national defense efforts, as well civilian innovators. The first general-purpose Chinese quantum computer could have a million times the computing power of all other computers currently in the world.

*Tags: S&T policy, Foreign S&T, Quantum science, S&T China*

### [‘Transformative’ research unrealistic to predict, scientists tell granting agencies](#)

[Science Daily, 05OCT2017](#)

Transformative research (TR) statements in scientific grant proposals have become mainstream. TR is defined as radically changing our understanding of a concept, causing a paradigm shift, or opening new frontiers. According to a study by researchers at Oregon State University, it is rarely possible to predict the transformative nature of research. Interviews and surveys of 78 transformative ecologists suggest that most TR began with incremental goals, while transformative potential was recognized later. Most respondents thought TR is unpredictable and should not be prioritized over ‘incremental’ research that typically leads to breakthroughs. They recommend that granting agencies allocate only a subset of funds to TR and solicit more realistic proposal statements. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: S&T policy, Science without borders*

## SCIENCE WITHOUT BORDERS

### [New study proposes a giant, space-based solar flare shield for earth](#)

[Physorg.com, 06OCT2017](#)

In a study, researchers at Harvard University predict that within ~150 years, there will be an event that causes damage comparable to the current US GDP of ~20 trillion dollars, and the damage will increase exponentially at later times until technological development will saturate. To address this growing risk, they considered the possibility

of placing a magnetic shield between Earth and the sun where it would be able to deflect charged particles and create an artificial bowshock around Earth. According to the researchers, such a shield is technically feasible in terms of its basic physical parameters and could be built at a fraction of the cost of what would be incurred from solar flare damage. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Science without borders*

### [Where Does IBM Research Get Ideas? Open Mikes and Interns](#)

[IEEE Spectrum, 06OCT2017](#)

At IBM, research projects often originate from open mike sessions, held once a year, where one or two dozen people stand on stage and pitch in the first round. With feedback from the audience, in a free-flowing Q&A, the researchers usually winnow themselves down to three or four. They then flesh out the ideas, including how many people they will need from where in the organization and winnow that down to one or two projects. IBM's neuromorphic chip, for example, came out of an open mike session in 2006. IBM also sets its research agenda in a more formal process, involving all its labs around the world.

*Tags: Science without borders, Disruptive technology, Emerging technology*

### [Fingerprints lack scientific basis for legal certainty](#)

[Science Daily, 05OCT2017](#)

In a new report, a team of researchers in the US (industry partner, UC Irvine, Michigan State University, Carnegie Mellon University) argues that, while latent fingerprint examiners can successfully rule out most of the population from being the source of a latent fingerprint based on observed features, insufficient data exist to determine how fingerprint features really are unique. This makes it scientifically baseless to claim that an analysis has enabled examiners to narrow the pool of sources to a single person. The 14 recommendations in the report constitute a roadmap for further research.

*Tags: Science without borders, Pattern recognition*

### [One-Way Salesman Finds Fast Path Home](#)

[Quanta Magazine, 05OCT2017](#)

An international team of researchers (Switzerland, UK) has developed a technique built upon the constant-factor approximation algorithm for the special case of node-weighted metrics to solve an asymmetric traveling salesman problem. They give a generic reduction to structured instances that resemble but are more general than those arising from node-weighted metrics. For those instances, they then solve Local-Connectivity ATSP, a problem known to be equivalent (in terms of constant-factor approximation) to the asymmetric traveling salesman problem. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Science without borders, Mathematics*

## SENSORS

### [Air Force, Navy team up to acquire new counter radio-controlled explosive technology](#)

[Defense Systems, 05OCT2017](#)

The new Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare Increment One Built One (JCREW I1B1) JCREW systems will integrate existing CREW systems into one open-architecture platform to provide easier defense from RCIED threats. Integrating the capabilities of these systems into one requires increasing the similarities between the dismantled, mobiles, and fixed systems, so different features can be easily navigable in one device. JCREW I1B1 systems are software programmable, have reduced maintenance expenses, and have a simpler updating process.

*Tags: Sensors, Military technology*

### [Do earthquakes have a 'tell'?](#)

[Science Daily, 05OCT2017](#)

Deep tremor is very sensitive to small stress changes. An international team of researchers (USA - Northwestern University, Georgia Institute of Technology, USGS Alaska, Taiwan, Japan) used them as stress meters to monitor local variations in stress build-up and release before and after large earthquakes. They applied their algorithms to data from 10 seismic stations in Taiwan and found that deep tremor started to change its behavior about two months before the occurrence of a 6.4-magnitude earthquake in March 2010. By combining data from earth observatories, such as GPS and seismic stations, with statistics and a series of algorithms, the team showed that changes in deep tremor patterns could signal an impending earthquake nearby. [TECHNICAL ARTICLE](#)

*Tags: Sensors*

### [New Radar Sensor Provides Clear Vision in Any Weather](#)

[DARPA News, 28SEP2017](#)

DARPA's Video Synthetic Aperture Radar (ViSAR) program recently completed flight tests, successfully demonstrating a new sensor that can capture real-time video through clouds. The ViSAR program has demonstrated and continues to push technology innovations in four technical areas: Compact flyable EHF-band exciters and receivers; Compact flyable medium-power amplifier; Scene simulation; and Advanced algorithms. The next phase of the ViSAR program is to integrate the sensor into an aircraft that includes a complete battle management system and capable of real-time target engagement. The ViSAR program, which began in 2013, has been developing an EHF targeting sensor to operate through clouds as effectively as current EO/IR sensors operate in clear weather.

*Tags: Sensors, DARPA ■*

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