Thinkstock

Mimicking Fireflies

Illustration of fireflies giving off light in the night.

Bio-inspired coating increases LED efficiency by 55 percent.

Taking a cue from master engineer Mother Nature, researchers have figured out how a type of firefly gives off light (Opt. Express **21**, 764) and used the results to raise the light-extraction efficiency of an existing LED by 55 percent (Opt. Express **21**, A179).

Annick Bay, a doctoral student at the University of Namur (Belgium), and her colleagues studied the morphology of the segments of the luminescent abdomens of fireflies of the genus *Photuris*. They modeled the propagation of 560 nm light—close to the peak wavelength of the flies' emission—within these structures, and they experimentally checked their calculations by measuring the radiance of light beamed through pieces of the insects' abdomens.

The team found that *Photuris* has "misfit" chitin scales, with one edge of each scale protruding a few micrometers outward. The scales create a corrugated "factory roof" surface that improves light extraction from the abdomen over a flat surface with the same refractive index. They used this pattern to design an LED overlayer, which increased light extraction by 55 percent. The researchers speculate that, with achievable modifications to current manufacturing techniques, it should be possible to apply these novel, energy-saving design enhancements to current LED production within the next few years.
—Patricia Daukantas

tweeted

@drskyskull (Greg Gbur)

Mathematics and I have been together for so long that our relationship has become strained. #SHUTUPSTUPIDMATHEMATICS

@scottyorange (Scotty Orange)

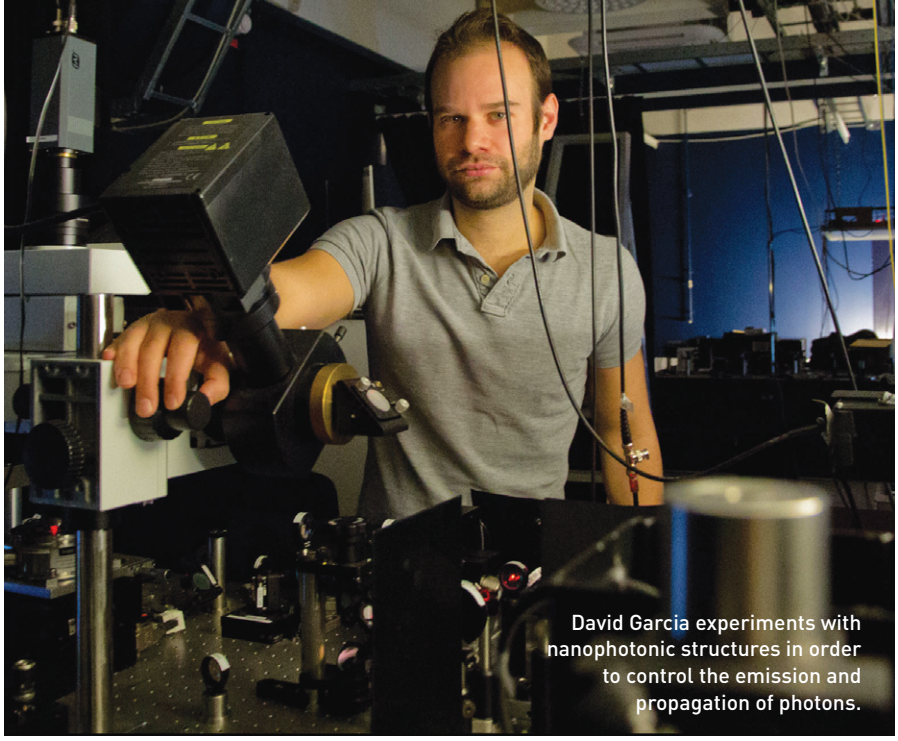
Breaking up a party made of helium, krypton, and nitrogen with oxygen. #lowTemperaturePhysics

@ZuLya (Zuleykhan Tomova)

"Nobody said it would be easy; just try harder." It rings a bell—exactly what I keep saying to myself.

@mmlee (Meredith Lee) Yesterday: all-day chemistry lab excitement & design sessions for India solar/water/food project. Today: lasers & healthcare!

@tweetsoutloud (Bobak Ferdowski) **@AnneWheaton** hey I want to help on this secret project too! Skills include: PowerPoint, landing rovers on Mars, ridiculous hair.



David Garcia experiments with nanophotonic structures in order to control the emission and propagation of photons.

Ola Jakup Joensen, Niels Bohr Institute

Light **Labyrinth**

Coordinating random scattered photons.

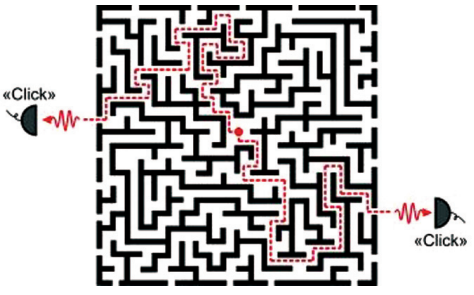
Can something be both random and organized? Apparently so. Although light scattering is a random process, photons emitted in a complex and disordered structure can travel mutually coordinated paths, according to researchers at the Niels Bohr Institute at the University of Copenhagen (Denmark). The findings provide new ways of enhancing light-matter interaction for quantum electrodynamics and energy harvesting and may find applications in subwavelength diffuse-wave spectroscopy for biophotonics.

Researcher David Garcia and his team tracked photons emitted by a quantum dot embedded in a disordered photonic crystal (Phys. Rev. Lett. **109**, 253902). Due to the wavelike nature of light, the photons took different paths but were interdependent in the sense that the chance of observing a photon at one outlet was increased if another photon is seen at the other.

The emitters probed the microscopic details of the medium and imprinted the near-field properties onto the far-field correlations.

Garcia explains: "The photons are scattered in all directions … But photons are not just light particles, they are also waves, and waves interact with each other. This creates a link between the photons, and we can now demonstrate in our experiments that the photons' path through the material is not independent from the other photons."

The method might someday be used to measure the spatial properties of complex disordered materials such as biological tissue. —*Yvonne Carts-Powell*



A visual representation of photons navigating from the center of a labyrinth by random scattering.

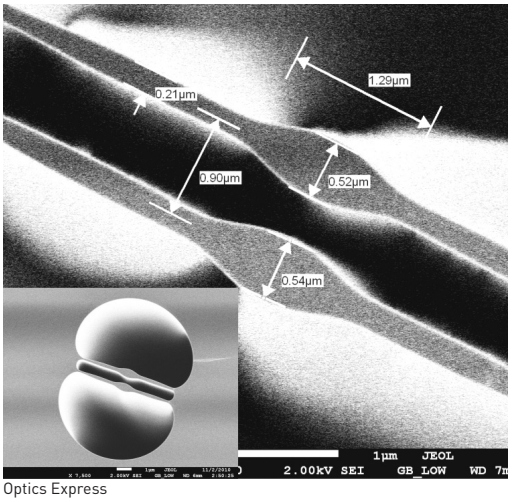
Optical clocks can slice time into **quadrillionths of a second**—which is a million times smaller than a billionth of a second.

Mechanical Switching
Inside Optical Fibers

Once drawn, optical fibers are usually mechanically rigid—in other words, frozen forever. But scientists in the United Kingdom have used tiny mechanical interior movements to switch light between the two cores of a single glass fiber (Opt. Express **20**, 29386). The experiments could lead to "smart fibers" for many telecommunications and sensing applications.

Research associate Zhenggang Lian and his colleagues at the University of Southampton's Optoelectronics Research Centre constructed the nanomechanical fiber out of lead silicate glass, with the two cores independently suspended and yet optically coupled. At one point along the fiber, the researchers etched away the cladding to provide the outside environment with access to one of the cores.

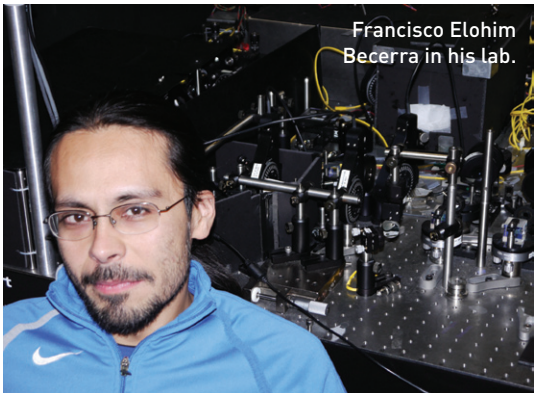
The altered section was passed through a nitrogen-filled pressure chamber, which the team used to apply selective pressure on one of the cores. The researchers beamed polarized diode-laser light at a standard telecom wavelength (1,550 nm) down the fiber. By varying the chamber pressure by a few hundred millibars, the team moved one core by as much as 8 nm and switched the light between the two cores.



A cross-section (inset) and magnification of the nano-mechanical fiber.
Optics Express

In future applications, electrostatic actuators, which are now used in many micro-electro-mechanical systems, could perform the tiny mechanical movements more quickly than the external pressure changes. Such nanoscale devices within fibers could move some of the switching, buffering and routing functions of a network from optoelectronic chips to the fibers themselves. Sensors could benefit from the fibers' ability to detect minuscule pressure changes or vibrations in the environment. —*Patricia Daukantas*

New solar power installations in Germany hit a record high in 2012—capacity grew by more than **7.6 gigawatts**.



Francisco Elohim Becerra in his lab.

Beating the Quantum Limit in Optical Communications

Teasing meaningful information out of a weak signal—whether in a child's game of "telephone" or an optical network—can be difficult or impossible due to intrinsic noise. Now, scientists at the Joint Quantum Institute (JQI; U.S.A.) have devised a method for lowering the error rate of a quantum system below the standard quantum limit, which could lead to more efficient communications (Nature Photon, doi: 10.1038/nphoton.2012.316).

An ideal, 100-percent-efficient receiver can distinguish nonorthogonal coherent states down to a certain minimum level of error probability known as the standard quantum limit, according to Francisco Elohim Becerra, a postdoctoral researcher at JQI. Scientists can squeeze more information into a signal by encoding the data into multiple phases of light, but the higher the number of states or phases, the more difficult it is to distinguish them at the receiver, especially with low-intensity signals.

To "beat" the standard limit, the JQI team devised an adaptive feedback system that makes multiple assessments of the phase of the incoming signal. The receiver uses the first measurement to adjust itself before making the next measurement. The researchers tracked the experimental error probability involved in distinguishing among four states in the format known as quadrature phase-shift keying. The experiment yielded error probability that is 6 dB below the standard quantum limit for an ideal receiver. —*Patricia Daukantas*

Focusing Light to a Nanoscale Point

Squeezing light down to the smallest possible space is crucial for integrating tiny devices onto a single photonic chip and performing biomedical imaging. Scientists in California have built a tiny plasmonic waveguide that "nanofocuses" near-infrared light to a point less than 100 nm wide (Nature Photon., doi: 10.1038/nphoton.2012.277).

The tapered structure, consisting of silicon dioxide sandwiched between two layers of gold, is less than 2 μm in overall length, says Hyuck Choo, assistant professor of electrical engineering at the California Institute of Technology in Pasadena. The waveguide compresses light in the two dimensions perpendicular to the propagation of the radiation.

Computer simulations revealed the optimal geometry for the taper to produce nanofocusing. The bottom of the device remains flat for ease of on-chip implementation, with the sides and top narrowing from front to back.

The team focused 830-nm light from a femtosecond laser into a spot 14 nm by 80 nm, with an intensity 400 times greater than the original beam. By the group's calculations, the smallest possible pinpoint of light that the tapered waveguide could produce would be 2 nm wide and 5 nm long, although they have not yet achieved that experimentally. —*Patricia Daukantas*

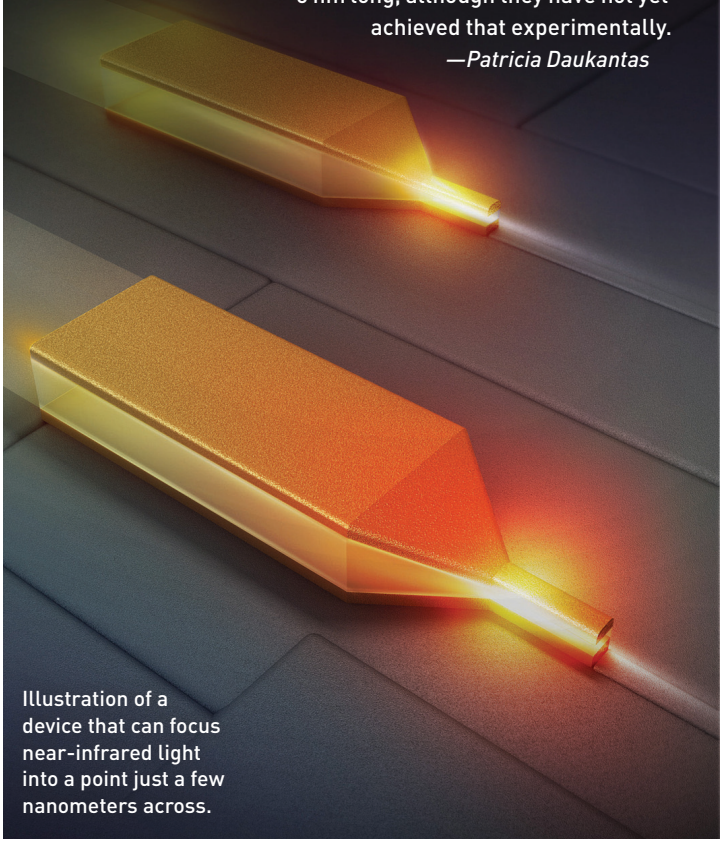


Illustration of a device that can focus near-infrared light into a point just a few nanometers across.

Young-Hee Lee, Caltech

POLICY

113th Congressional Committee Guides

Between the 2012 U.S. elections, retirements and committee chairmanship term limits, the new Congress holds a lot of changes for House and Senate committee rosters. To keep track of who's who and what's in store for the upcoming term, the OSA public policy team has put together committee-by-committee guides for both chambers. You can find them online at www.osa.org/about_osa/public_policy/washington_updates/.

Something New on the EU Horizon

"Horizon 2020" is the new, integrated funding system that will cover all research and innovation funding currently provided through the Framework Programme for Research and Technical Development, the Competitiveness and Innovation Framework Programme and the European Institute of Innovation and Technology. It combines these funding mechanisms in a way that allows for more award flexibility.

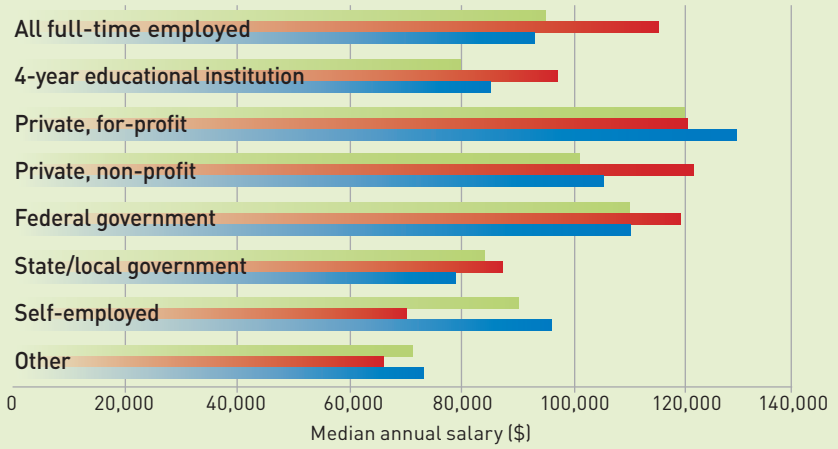
Horizon 2020 is a seven-year program that will evolve to incorporate a broader economic and policy framework as it progresses, with the goal of delivering ideas, growth and jobs for the future. It also will be a key tool in implementing the Innovation Union flagship initiative, which is aimed at securing Europe's global competitiveness.

The proposed support for research and innovation under Horizon 2020 will:

- strengthen the EU's position in science
- bolster industrial leadership in innovation, including major investments in technology and small- and medium-sized enterprises; and
- address concerns shared by most Europeans, including climate change, affordable renewable energy, elder care and food safety.

For information on funding opportunities, visit www.osa-opn.org/home/#tab-randd.

Salary Watch



In early 2013, the U.S. National Center for Science and Engineering Statistics released data on doctoral-level scientist and engineer salaries. The report includes information from 2010 on full-time employees in several sectors. Engineers reported median annual salaries ($115,000) that were higher than those reported by health and science doctorates ($95,000 and $93,000, respectively).

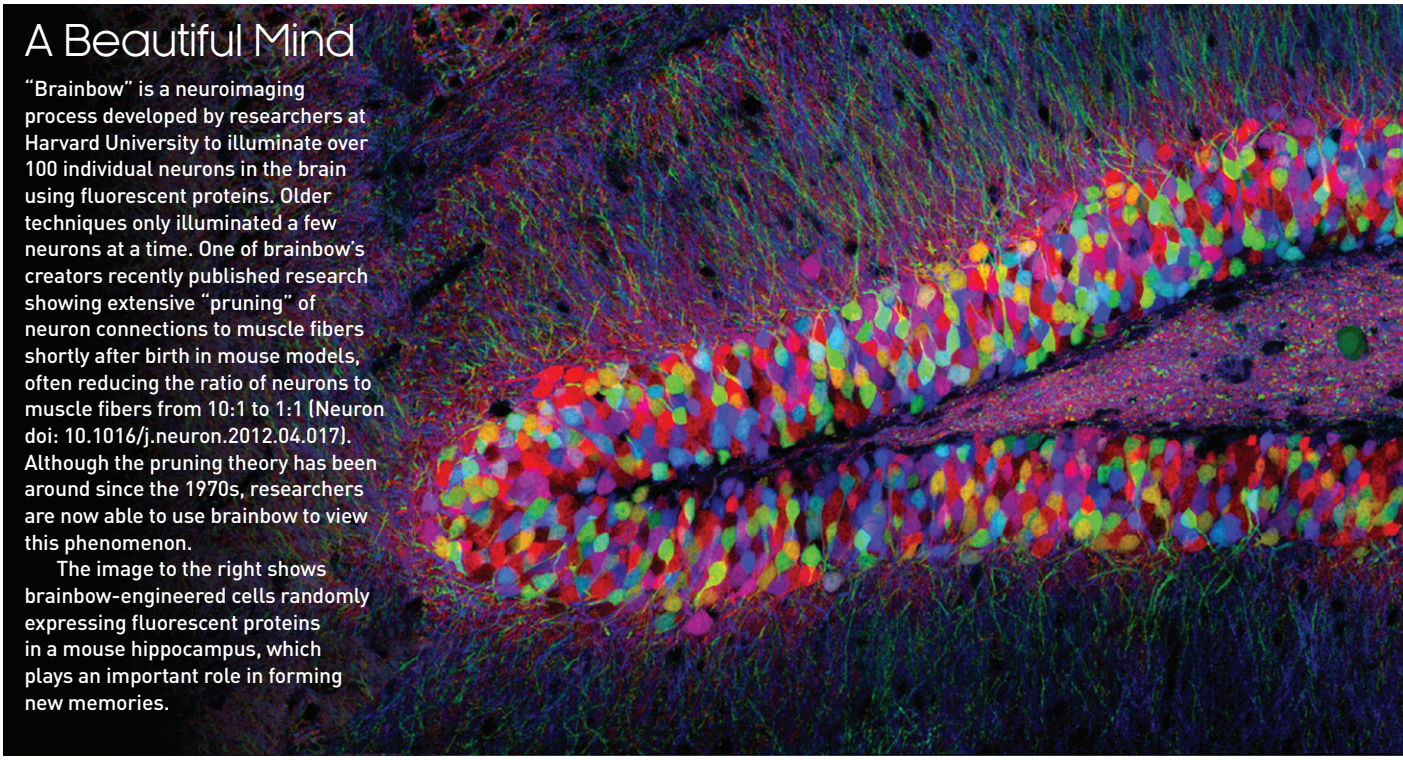
Adapted from NSF/National Center for Science and Engineering Statistics, Survey of Doctorate Recipients, 2010.

By 1662, Pierre de Fermat perfected his **least-time proof** of the sine law, which treats light as a particle shooting through space.

A Beautiful Mind

"Brainbow" is a neuroimaging process developed by researchers at Harvard University to illuminate over 100 individual neurons in the brain using fluorescent proteins. Older techniques only illuminated a few neurons at a time. One of brainbow's creators recently published research showing extensive "pruning" of neuron connections to muscle fibers shortly after birth in mouse models, often reducing the ratio of neurons to muscle fibers from 10:1 to 1:1 (Neuron doi: 10.1016/j.neuron.2012.04.017). Although the pruning theory has been around since the 1970s, researchers are now able to use brainbow to view this phenomenon.

The image to the right shows brainbow-engineered cells randomly expressing fluorescent proteins in a mouse hippocampus, which plays an important role in forming new memories.



Joanna Wessman, Jean Livet, Joshua Sanes and Jeff Lichtman, Harvard University

INDUSTRY

Strong Component Growth Predicted through 2019

A report released by Wintergreen Research (Lexington, Mass., U.S.A.) estimates that the optical component market will grow from $3.6 billion in 2012 to $12.3 billion by 2019. *Optical Components: Market Shares, Strategy, and Forecasts, Worldwide, 2013 to 2019*, available for purchase at www.Researchand-Markets.com, covers optical communication network elements and infrastructure, which are expected to surge along with the growth of smart phone use and Internet data transmission. —*Valerie Coffey*

LG Electronics

OLED TVs Reach Consumer Market

LG Electronics (Korea) launched a commercially available organic LED (OLED) television at this year's Consumer Electronics Show (CES). The 55" OLED screen TVs will go on sale for about KRW 11M (US $10,000).

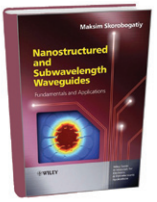
OLED TV technology enables the elimination of a backlight, resulting in ultra-thin displays only 4 mm thick compared to the conventional flat-screen thickness of 15 mm. The weight of the set is thus reduced to 10 kg (22 lb). OLED TVs also use less power to produce brighter and sharper images compared to LCD and plasma displays.

Samsung introduced a 55" OLED TV prototype at CES 2013, but a commercial launch date had not yet been announced as of press time. —*Valerie Coffey*

Patricia Daukantas, Yvonne Carts-Powell and Valerie Coffey are freelance science writers who specialize in optics and photonics. Sarah Michaud is OPN's associate editor.

BOOK REVIEWS

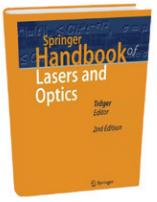
Nanostructured and Subwavelength Waveguides: Fundamentals and Applications



Maksim Skorobogatiy, Wiley, 2012; $155.00 (hardcover).

This book stands at the confluence of a number of fast-flowing streams in physics research: metamaterials, polar materials, plasmonics and nano-optics. Skorobogatiy provides a comprehensive range of mathematical and analytical approaches to treat nanostructured and subwavelength waveguides in widely different contexts. —*K. Alan Shore*

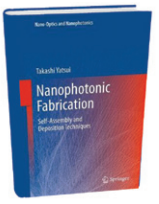
Springer Handbook of Lasers and Optics, 2nd Edition



Frank Träger, ed., Springer, 2012; $339.00 (hardcover).

I recommend this modern, comprehensive handbook to students, educators, engineers and scientists. The chapters are clearly written and include sophisticated illustrations that augment the text. The tables of data are also exemplary. The authors strike a good balance between theory and implementation. —*Barry R. Masters*

Nanophotonic Fabrication: Self-Assembly and Deposition Techniques



Takashi Yatsui, Springer, 2012; $129.00 (hardcover).

Nanophotonics is a novel optical technology that utilizes the local interaction between nanometric particles via optical near-fields. This introduction to nanophotonic fabrication is aimed at readers who are interested in various functions that differ depending on the device. —*Lisa Tongning Li*

The Emergent Multiverse: Quantum Theory According to the Everett Interpretation

David Wallace, Oxford University Press, 2012; $75.00 (hardcover).

David Wallace, a physicist and philosopher, has written a modern account of the Everett interpretation of quantum mechanics, and its logical consequences and extensions. Readers who are familiar with basic quantum mechanics, probability theory and decision theory would be well-suited to tackle the mathematical and logical arguments presented here. —*Barry R. Masters*

ONLINE EXTRA

Visit www.osa-opn.org for additional book reviews.

Lisa Tongning Li is from Livermore, Calif., U.S.A. Barry R. Masters is a Fellow of AAAS, OSA and SPIE. He is with the department of biological engineering at the Massachusetts Institute of Technology in Cambridge, Mass., U.S.A. K. Alan Shore is from the Bangor University School of Electronic Engineering, Wales, United Kingdom.