



Machine learning with light

Carefully patterned green light is projected onto a lithium niobate photonic chip with a photoconductive layer. This allows near-arbitrary control of light propagation within the chip that, in turn, enables the performance of linear computations for neural networks.

See [Tatsuhiko Onodera et al.](#)

Image: Martin Stein, Cornell University. Cover design: Laetia Mac Gabhann

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Editorial

Editorial
15 Jan 2026

An alternate chapter in magnetism

A recently proposed class of magnets, so-called altermagnets, combine features of ferromagnets and antiferromagnets. We discuss the scientific appeal of altermagnets, current controversies and challenges for their practical use.

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Comment

Comment
15 Jan 2026

Traceability for protein sequence to function

How proteins — sequences of amino acids — fold determines their function. We discuss efforts towards the establishment of metrics traceable to the International System of Units that track the sequence of a protein to its structure and function.

Amandine Boët, Gustavo Martos ... Maxim G. Ryadov

[Partner content](#)

A roadmap to the quantum internet

The largest quantum network in the United States is set to expand further as its designers aim to deliver an economic engine for New York and beyond.

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Thesis

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A star of contradictions

Mark Buchanan

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News & Views

News & Views
19 Dec 2025

Chirality helps malaria parasites reach their target

Malaria parasites rapidly glide through host tissues in right-handed spirals. A tilted architecture and asymmetric forces power this chiral motion and help them to transition between different environments.

Georgios Pavlou & Isabelle Tardieux

News & Views
08 Jan 2026

Bacteria may not be good at chemotaxis

Bacteria appear to be masters of chemotaxis, but it is unclear how well they process chemical information. A study now argues that cells squander most sensory information, making chemotaxis far less efficient than established physical limits allow.

Robert G. Endres

News & Views
05 Jan 2026

Embryo geometry sets the tempo

The geometry of the zebrafish egg is shown to generate a gradient in cell size upon successive cell divisions. This gradient specifies stereotyped patterns of cell-cycle progression, zygotic genome activation and cell-fate specification.

Jeremy Salik & Nicolas Minc

News & Views
15 Jan 2026

Preferential play

David Abergel

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Research Briefings

Research Briefing
11 Dec 2025

A super-conducting diode with ultimate efficiency and noise resilience at 77 K

An electrical method is shown to reliably introduce nonreciprocal behaviour across a Josephson junction made of high-temperature cuprate superconductors, which then, under microwave irradiation, forms a 'quantum superconducting diode'. The device is magnetic-field-free, works at a temperature of 77 K with a diode efficiency of 100%, and, owing to Shapiro steps that quantize the output voltage, has robust noise-filtering.

Research Briefing
30 Dec 2025

Experimental evidence of a spatially textured electron fluid

In most metals, free electrons form a homogeneous and isotropic fluid. However, a periodically modulated electronic fluid — known as a liquid charge density wave — is thought to form when electrons interact strongly with the vibrations of the crystalline host. This state is now observed using ultrafast electron diffraction.

Research Briefing
28 Nov 2025

Momentum mixing solves the Mott problem

Adding momentum mixing in a controllable way to the exactly solvable Hsuagai-Kohmoto model is shown to recover the physics of the Hubbard model, the starting point for understanding Mott physics. The scheme converges as the inverse square of the number of steps, and, as each step is tractable, minimal computational resources are required.

Research Briefing
07 Jan 2026

A non-equilibrium model for ultrasensitive switching in bacterial flagellar motors

Bacterial motors respond to chemical signals with high sensitivity to control cell swimming behaviour. However, the established model that describes how this sensitivity arises is an equilibrium model, which is inconsistent with experimental findings. A model is now proposed in which high sensitivity results from non-equilibrium mechanical interactions within the motor.

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Articles

Article
19 Nov 2025

Observation of a dynamic transition in bulk supercooled water

Water has remarkable dynamic properties: a transition from a fragile to a strong liquid has been proposed to explain how they change on cooling. Experiments now show evidence for such a transition in bulk supercooled water at around 233 K.

R. Tyburski, M. Shin ... K. H. Kim

Article
[Open Access](#)
26 Nov 2025

Fault-tolerant quantum computation with polylogarithmic time and constant space overheads

Quantum low-density parity-check codes are anticipated to be an efficient approach to quantum error correction. Now it has been proven that these codes can be time-efficient with only a constant overhead in the required number of qubits.

Shiro Tamiya, Masato Koashi & Hayata Yamasaki

Article
11 Nov 2025

Field-tunable valley coupling in a dodecagonal semiconductor quasicrystal

Lacking translational symmetry, the momentum-space description of quasicrystals is distinct from that of fully crystalline materials. Now, a quasicrystal with two 2D layers links different momenta from the individual layers, allowing new excitons to form.

Zhida Liu, Qiang Gao ... Xiaoqin Li

Article
06 Jan 2026

Optical control of orbital magnetism in magic-angle twisted bilayer graphene

Strong correlations and topology have been seen in moiré graphene, but their optical control has not been shown yet. Now, the optical manipulation of orbital magnetism and anomalous Hall effects is demonstrated in magic-angle twisted bilayer graphene.

Eylon Persky, Léonie Parisot ... Aharon Kapitulnik

Article
28 Nov 2025

Quantum superconducting diode effect with perfect efficiency above liquid-nitrogen temperature

A device for rectifying supercurrents at liquid-nitrogen temperature with high efficiency is demonstrated. This is a practical step towards implementing dissipatorless electronics.

Heng Wang, Yuying Zhu ... Ding Zhang

Article
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26 Nov 2025

Non-local detection of coherent Yu–Shiba–Rusinov quantum projections

Coherently projecting a quantum state may allow it to be probed from a distance. This is now demonstrated for a Yu–Shiba–Rusinov state using a quantum corral.

Khai That Ton, Chang Xu ... Jens Wiebe

Article
24 Nov 2025

Electric toroidal invariance generates distinct transverse electromagnetic responses

Magnetic toroidal invariance generates transverse electromagnetic effects in materials with broken symmetries. Now a distinct magnetic response is shown to emerge in ferro-rotational systems in which both inversion and time-reversal symmetries are preserved.

Kai Du, Daegyun Jo ... Sang-Wook Cheong

Article
30 Dec 2025

Observation of a hidden charge density wave liquid

Liquid charge density wave order is thought to occur in many correlated electron systems but has not been observed experimentally. Now, a liquid-like electronic state is shown to emerge in a transition metal dichalcogenide on photoexcitation.

Joshua S. H. Lee, Thomas M. Sutter ... Anshul Kogar

Article
12 Dec 2025

Optimal operation of hole spin qubits

Hole spin semiconductor qubits suffer from charge noise, but now it has been demonstrated that placing them in an appropriately oriented magnetic field can suppress this noise and improve qubit performance.

M. Bassi, E. A. Rodriguez-Mena ... V. Schmitt

Article
27 Nov 2025

Twisting the Hubbard model into the momentum-mixing Hsuagai–Kohmoto model

The Hubbard model describes the physics of strongly correlated electron systems, but is difficult to solve. Now, a scheme to systematically and efficiently relate the exactly solvable Hsuagai–Kohmoto model to the Hubbard model has been identified.

Peishi Mai, Jinchao Zhao ... Philip W. Phillips

Article
17 Nov 2025

Effective bands and band-like electron transport in amorphous solids

The standard band structure picture cannot be applied to amorphous materials as they lack crystal symmetry. Now a first-principles approach that captures the possibility of band-like electron transport in amorphous solids is presented, with In_2O_3 as an example.

Matthew Jankovsky, Dimitar Pashov ... Vladan Stevanović

Article
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02 Dec 2025

Protein pattern morphology and dynamics emerging from effective interfacial tension

Protein patterns enable cellular processes. A general theory now identifies a non-equilibrium mechanism that generates an effective interfacial tension, shaping the geometry and intrinsic length scales of steady-state protein patterns.

Henrik Weyer, Tobias A. Roth & Erwin Frey

Article
[Open Access](#)
15 Dec 2025

Fusion and fission of particle-like chiral nematic vortex knots

Topologically protected vortex knots are shown to undergo fusion and fission, with electric pulses acting as a switch between the two processes. This might enable applications in electro-optics and photonics.

Darian Hall, Jung-Shen Benny Tai ... Ivan I. Smalyukh

Article
24 Nov 2025

Chirality of malaria parasites determines their motion patterns

Malaria parasites move on helical trajectories when infecting their hosts. Now it is shown that they use right-handed chirality to control their motion patterns, and that this chirality is linked to the way they release adhesion molecules.

Leon Lettermann, Mirko Singer ... Ulrich S. Schwarz

Article
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08 Jan 2026

E. coli chemosensing accuracy is not limited by stochastic molecule arrivals

The chemosensing accuracy of *E. coli* cells is shown to be limited by internal noise in signal processing, rather than the stochasticity of molecule arrivals at their receptors, contrary to long-held understanding in the field.

Henry H. Mattingly, Keita Kamino ... Benjamin B. Machta

Article
07 Jan 2026

Mechanical origin for non-equilibrium ultrasensitivity in the bacterial flagellar motor

Bacterial flagellar motors switch rotation direction with high sensitivity to environmental inputs. A theoretical model explains how torque-dependent non-equilibrium switching contributes to ultrasensitivity.

Henry H. Mattingly & Yuhai Tu

Article
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05 Jan 2026

Geometry-driven asymmetric cell divisions pattern cell cycles and zygotic genome activation in the zebrafish embryo

Many different biochemical and mechanical signals control morphogenesis. Now it is shown that the geometry of the fertilized egg helps orchestrate spatial and temporal patterning during embryogenesis.

Nikhil Mishra, Yuting Irene Li ... Carl-Philipp Heisenberg

Article
04 Dec 2025

Twist-induced non-Hermitian topology of exciton–polaritons

Strongly coupled light–matter systems could offer enhanced manipulation of topological phenomena. Now, tunable non-Hermitian effects are demonstrated with exciton–polaritons induced by a twist degree of freedom.

Jie Liang, Hao Zheng ... Rui Su

Article
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02 Jan 2026

Self-induced superradiant lasing

Superradiance is usually driven by light-mediated couplings, leaving the role of direct emitter interactions unclear. Now, it is shown that dipole–dipole interactions in diamond spins drive self-induced pulsed and continuous superradiant lasing.

Wenzel Kersten, Nikolaus de Zordo ... Jörg Schmiedmayer

Article
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08 Dec 2025

Arbitrary control over multimode wave propagation for machine learning

Photonic processors are limited by the bulkiness of discrete components and wiring complexity. An experiment now demonstrates a reprogrammable two-dimensional waveguide that performs neural network inference through multimode wave propagation.

Tatsuhiko Onodera, Martin M. Stein ... Peter L. McMahon

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Measure for Measure

Measure for Measure
15 Jan 2026

An anniversary annum

As our metrology column turns ten years, there is no better way to celebrate than to look at the definitions of a year, finds Stefanie Reichert.

Stefanie Reichert

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