

Physical sciences articles within Nature Communications Atom RSS Feed

Featured

Article
02 December 2025 | Open Access
Ultrathin Single-Walled Carbon Nanotube Surface Wave Absorbers for Terahertz Dielectric Waveguides
Nanometer-thin single-walled carbon nanotube films on silicon terahertz waveguides absorb surface waves with low reflection across 140–220 GHz, enabling ultrabroadband matched terminations and record lightning performance for terahertz circuits.
Nikolaos Xenidis, Mehdiad Rezaei Gohghard & Dmitry V. Loubchenco

Article
02 December 2025 | Open Access
Ratiometric detection of perfluoroalkyl carboxylic acids using dual fluorescent nanoparticles and a miniaturized microfluidic platform
Legislative measures and an increased need for remediation of perfluoroalkyl substances (PFAS) require PFAS sensors for environmental monitoring. Here, the authors develop a green-fluorescent quaternary BODIPY indicator monomer incorporated into a molecularly imprinted polymer for the selective detection of PFCA and related compounds.
Yuehui Zhao, Yuxin He, Xueping Li & Xianfeng Guo

Article
02 December 2025 | Open Access
An ammonia-induced universal synthesis approach for manganese-based layered oxides
Developing positive electrodes with high stability and rapid ion migration kinetics faces challenges for sodium ion batteries. Here, authors report a universal synthesis approach for layered transition-metal oxides by updating the conventional solid-state reaction with only dicyanamide introduced.
Yuan Zhu, Zhongqiang Qiu & Li Li

Article
02 December 2025 | Open Access
Antomalous rotational symmetry breaking in proton arrangement of surface-confined cyclic hydrogen bonds revealed by atomic force spectroscopy
Detecting proton arrangements and quantum behavior at the atomic level is a challenge. Here, the authors use atomic force spectroscopy to reveal symmetry breaking in the proton arrangement in cyclic hydrogen bonds caused by nuclear quantum effects.
Feng Guo, Chunlei Yang & Yi-Qi Zhang

Article
02 December 2025 | Open Access
Tunable ion selectivity in vermiculite membranes intercalated with unexchangeable ions
Membranes selective to ions of the same charge are sought for water waste processing and valuable element recovery. Here authors show that ions intercalated into vermiculite lamellar interlayers become effectively unexchangeable, creating stable channels for processes such as cutting, healing, and self-healing.
Zhuang Liu, Yumei Tan & Marcello Locatelli-Hidalgo

Article
02 December 2025 | Open Access
Nanoscale reduction-site-selective oxygen regulation for promoting hydrogen peroxide production
Solar hydrogen peroxide production is hampered by a chemical conflict: the high oxygen levels needed for one reaction inhibit the other. Here, the authors assemble nanoscale oxygen traps selectively on reduction sites, creating ideal local environments to boost H₂O₂ yield.
Xiaoshan Zheng, Zhenhua Fan & Chifeng Chu

Article
02 December 2025 | Open Access
Halide insertion regulation for efficient and stable wide-bandgap perovskite photovoltaics
Understanding the crystallization mechanism of mixed halide wide-bandgap perovskites is critical to improve the performance of tandem solar cells. Here, the authors introduce optically-transparent to construct a π-conjugated molecular wall structure, achieving a maximum solar cell efficiency of 24.13%.
Zhen Song, He Meng & Tinghui He

Article
02 December 2025 | Open Access
Remodeling and self-healing of individual amyloid tactoids via multiphoton absorption
Controlling the shape and self-assembly of anisotropic colloidal systems is essential for developing heterogeneous liquid crystalline materials with adjustable properties and functions. This study utilizes stimuli-responsive photothermal manipulation to achieve reversible, sub-micron control of individual colloidal tactoids, showing for processes such as cutting, healing, and information storage.
Yuepeng Guo, Jiamin Alshammami & Raffaele Mezzenga

Article
02 December 2025 | Open Access
Tailoring precipitates for enhanced hydrogen trapping in aluminum alloys
The manuscript integrates molecular dynamics with first-principles calculations to determine practical processing parameters for H-capturing including metastable precipitates in Al alloys, reducing embrittlement by 78%.
Yucheng A, Xiaojian Fu & Peidong Dai

Article
02 December 2025 | Open Access
Tensile strain regulation via grain boundary buffering for flexible perovskite solar cells
The residual strain and modulus of polycrystalline films often limit the photovoltaic and mechanical performance of flexible perovskite solar cells. Here, the authors produce metal chelates for a uniformly distributed tensile strain field, achieving a maximum efficiency of 23.47%.
Zhiyong Xu, Ruman Yu & Zhensuo Fan

Article
02 December 2025 | Open Access
Room-temperature single-photon emission from β-Ga₂O₃
Single-photon emitters have been demonstrated in many wide-bandgap semiconductors and offer strong potential for quantum technology applications. Here the authors demonstrate room-temperature single-photon emission from β-gallium oxide, an emerging wide-bandgap semiconductor, opening new directions for research.
Yining Shi, Zhengchang Xia & Xingwang Zhang

Article
02 December 2025 | Open Access
Superior lead-free piezoceramics for wearable multimodal ultrasound imaging arrays
This study reports a flexible, lead-free ultrasound imaging array that enables real-time, high-resolution, and wearable imaging of human tissues, advancing safer and more portable ultrasound technology.
Haoyue Xue, Xing Huang & Jiajing Wu

Article
02 December 2025 | Open Access
Optomechanical sensor network with fiber Bragg gratings
The authors demonstrated a kilometer-scale optomechanical sensor network by integrating multiple fiber-optic optomechanical sensors into a standard single-mode fiber, enabling real-time monitoring of spatial DC and AC magnetic field variations induced by moving targets.
Shouyi Wang, Qing Zhang & Yongmin Li

Review Article
02 December 2025 | Open Access
Artificial intelligence for quantum computing
Quantum computing devices of increasing complexity are becoming more and more reliant on automated tools for design, optimization and operation. In this Review, the authors discuss recent developments in “AI for quantum”, from hardware design and control to circuit compiling, quantum error correction and postprocessing, and discuss future potential of quantum accelerated supercomputing, where AI, HPC, and quantum technologies converge.
Yi-Wei Chen, Yuxuan H. Fang & Timothy Coates

Article
02 December 2025 | Open Access
Bridging the gap between molecules and materials in quantum chemistry with localized active spaces
Emerging materials between molecules and materials demand new modeling approaches. Here, the authors present a localized active space approach that enables accurate and efficient band structure calculations to capture long-range charge and energy transfer in correlated materials.
Daniel S. King, Bhavesh Jangid & Laura Gallucci

Article
02 December 2025 | Open Access
Quasi-bound flat bands in the continuum
Quasi-BCs are known for their high sensitivity to structural disorder, which strongly affects their quality factor. Here, authors introduce quasi-bound flat bands in the continuum — crystal states originating from disorder-induced band folding. Their theoretical and experimental results provide a paradigm for designing devices of high-quality factor and broad angular response.
Haoyu Qiu, Wenxuan Zhang & Xiangdong Zhang

Article
02 December 2025 | Open Access
Revealing superconducting gap in La₂NiO₇ by Andreev reflection spectroscopy under high pressure
The gap structure of the newly-discovered nickelate superconductor La₂NiO_{7-δ} remains under debate due to challenges associated with the high pressure required. Here, the authors determine the gap using Andreev reflection spectroscopy, revealing strong coupling superconductivity in La₂NiO_{7-δ}.
Jianrong Guo, Yuzhi Chen & Tian Cui

Article
02 December 2025 | Open Access
Oxygen-mediated high uniform plasticity in α-β titanium alloys
The work transforms oxygen from an embrittling contaminant into a key asset in titanium alloys, successfully overcoming the strength-ductility trade-off and oxygen embrittlement.
Yuhui Wang, Jiaqi Wang & Jianghua Chen

Article
02 December 2025 | Open Access
Breaking the symmetry of high-entropy alloy surfaces for compressively strain-tuned oxygen reduction reaction
Breaking the symmetry of high-entropy alloy surfaces for delicate strain-tuning is highly appealing for electrocatalysis. Herein, high-entropy alloy nanorings with stress-release driven compressive strain at stepped defects are reported for efficient oxygen reduction reaction.
Lun He, Mengqiang Li & Shaojun Guo

Article
02 December 2025 | Open Access
Nuclear magnetic resonance for wireless magnetic tracking
This study introduces nuclear magnetic resonance (NMR) magnetic sensing for wireless tracking, enabling millimeter-scale accuracy and miniaturized trackers for guidewires, soft, and shape morphing medical devices.
M. Elv Toyaki, Pouya Emami-dokht & Martin Sitti

Article
02 December 2025 | Open Access
Self-doping of biological secretions for waste catalyst reuse
Authors converted waste ozonation catalysts into carbon-based nano-single-atom-site catalysts through in-situ carbonization of self-doped biological secretions, enabling efficient acceleration and resource reuse.
Min Li, Lige Fu & Changfeng Wu

Article
02 December 2025 | Open Access
Nature of 2D XY antiferromagnetism in a van der Waals monolayer
NPS is a van der Waals material, which in the bulk is antiferromagnetic. Whether the antiferromagnetism persists down to the monolayer remains a topic of debate. Here, through magnetotransport measurements, Chen et al. find that monolayer NPS exhibits two magnetic transitions, with a low temperature long-range ordered state.
Cheol-Yeon Cheon, Volodymyr Muftic & Dmitry Leshch

Article
01 December 2025 | Open Access
Real-space machine learning of correlation density functionals
Machine learning expands quantum chemistry’s reach, but it struggles to generalize to unseen chemistry. Here, the authors develop a real-space learning strategy based on energy densities to build highly transferable quantum-chemical models.
Eleni Riga, Heng Zhao & Stefan Vuckovic

Article
01 December 2025 | Open Access
Recyclable quasi-solid-state dynamic windows via reversible dual-metal electrodeposition for building energy modulation
In this work, the authors designed an optimized Cu₂ bimetallic hydrogel electrolyte and assembled a recyclable quasi-solid-state dynamic electrochromic window for building energy modulation.
Bing Xu, Weiting Wu & Jingwei Chen

Article
01 December 2025 | Open Access
Chiral and topological superconductivity in isospin polarized multilayer graphene
Recently, chiral superconductivity has been observed in rhombohedral tetralayer graphene under electron doping, arising from a spin- and valley-polarized normal state. Here, the authors propose a superconducting mechanism based on over-screening of Coulomb interaction due to charge fluctuations.
Max Geier, Margarita Davydova & Liang Fu

Article
01 December 2025 | Open Access
Enhanced superconductivity and coexisting ferroelectricity at oxide interfaces
The authors experimentally demonstrate the coexistence of superconductivity and ferroelectricity at LaNiO₃/SrTiO₃ interfaces. The superconducting transition temperature is enhanced due to ferroelectric polarization-induced reduction in dielectric constant, which narrows the interfacial potential well, confining carriers closer to the interface.
Meng Zhang, Meng Qiu & Yuxiu Xie

Article
01 December 2025 | Open Access
Nonlinear spatiotemporal signatures of whistler-mode wave activity around Mercury during six flybys of BepiColombo mission
Planetary flybys of spacecrafts offer rare opportunities to explore plasma environments in space. Here, the authors show that BepiColombo mission’s six Mercury flybys have detected coherent plasma waves, revealing nonlinear resonant interactions with energetic electrons.
Mitsuru Ozaki, Satoshi Yagita & Goro Murakami

Article
01 December 2025 | Open Access
Rapid estimation of protein folding pathways from sequence alone using AlphaFold2
Researchers find that AlphaFold2, despite imperfections, reveals folding intermediates and pathways, offering a fast heuristic for folding principles.
Lina Cheng, Alberto Perez

Article
01 December 2025 | Open Access
Ozone pollution monitoring using a full-time hyperspectral tomography system for multiple air pollutants
The study demonstrates a cost-effective hyperspectral tomography system for continuous monitoring of ozone and its precursors, using drones and light-emitting diodes. It provides high-resolution, all-day data, aiding in understanding pollution dynamics and identifying pollution sources.
Wanchao Ma, Chengchi Xing & Cheng Lu

Article
01 December 2025 | Open Access
Accurate geometric albedo, shape, and size of Hiʻaka from a stellar occultation
Hiʻaka is the largest moon of the distant dwarf planet Haumea. Here, the authors report the first multi-chord stellar occultations of Hiʻaka, revealing its size, shape, and density, suggesting an origin from Haumea’s icy mantle.
Estela Fernández-Vaquero, Jose Luis Ortiz & Jesús Morales

Article
01 December 2025 | Open Access
Ultrafast Coulomb blockade in an atomic-scale quantum dot
Directly observing ultrafast single-electron dynamics at the atomic scale remains a challenge. Here, the authors demonstrate ultrafast Coulomb blockade at selenium vacancies in WSe₂ graphene heterostructures using lightwave-driven scanning tunneling microscopy.
Jonas Altenback, Lutz Robitz & Bruno Schuler

Article
01 December 2025 | Open Access
Straightforward construction of functionalized γ-lactams via conjugated-engineered covalent organic framework photocatalysed cascade reactions
The synthesis of functionalized γ-lactams is challenging due to instability of the products and difficulties in controlling chain selectivity. Here, the authors report on the design and synthesis of a naphthalene-based pyrene-containing covalent organic framework and utilize it as a heterogeneous photocatalyst for synthesizing γ-lactams.
Xiangfeng Lin, Jiarong Li & Zhenhui Yuan

Article
01 December 2025 | Open Access
Pyruvate: an integrated design engine for RNA ordami
RNA provides biological oxygen structural and functional RNA architecture for biomedicine, synthetic biology and beyond. Here, the authors introduce pyruvate, an intuitive biosensor-based RNA design tool. With pyruvate, they realize the largest combinatorially foldable RNA nanostructures to date.
Li-Ming, Li, Braun & K. Götzlich

Article
01 December 2025 | Open Access
Hierarchical triple-channel architectures unlock scalable and high-efficient uranium extraction from seawater
The ocean holds ~4.5 billion tons of uranium but current seawater uranium adsorbents suffer from poor macroscopic structures, limited mass transfer, and inefficient functional group utilization. Here, the authors report a bio-inspired honeycomb-like polyamidoamine adsorbent featuring an interconnected hierarchical triple-channel architecture that addresses these challenges.
Hui Wang, Conghui Dai & Xinyi Wang

Article
01 December 2025 | Open Access
Observation of space-time surface plasmon polaritons
The authors report the observation of reflection-free space-time surface plasmon polaritons propagating along straight paths at metal-dielectric interfaces. This enhances the control of wavepacket propagation for nanophotonics applications.
Hadi Ullah, Hiba Ullah & Akshay Kumar

Article
01 December 2025 | Open Access
A nanoscale sensor for real-time in vivo monitoring of levodopa pharmacokinetics in precision Parkinson’s therapy
Real-time tracking of levodopa dynamics is key for precise Parkinson’s therapy. Here, the authors develop a centrifugal microfluidic system with a nano-MIP-functionalized carbon nanotube fiber sensor that achieves in vivo pharmacokinetic profiling and guides dosing regimen optimization.
Yue Zhang, Jiaqi Li & Bo Liang

Article
01 December 2025 | Open Access
Water-resistant redox-active metal-organic framework
Here, the authors develop a water-resistant redox-active metal-organic framework (RAMOF) featuring charge storage capability in aqueous electrolytes, and demonstrate an aqueous RAMOF-an rechargeable battery and material recyclability of the RAMOF.
Ryota Akai, Shoya Kijima & Kouki Oka

Article
01 December 2025 | Open Access
Experimentally achieving minimal dissipation via thermodynamically optimal transport
Optimal transport theory has been applied across diverse fields including robotics, algorithms, thermodynamics. The authors present experimental realization for optimal transport of microparticles, minimizing energy cost within finite time, and optimal finite-time information erasure.
Shingo Okawa, Yohei Nakayama & Shoichi Toyabe

Article
01 December 2025 | Open Access
Horizontally oriented compact colloidal quantum well films enable efficient and stable electroluminescent diodes
Ba et al. report a scalable approach combining two-phase driving and Langmuir-Schaeffer deposition, enabling colloidal quantum well films with 10% horizontal dipole alignment, yielding low LTQs with EQE of 25.5%, luminance of 95,620 cd/m², stability over 16,233 h, and maintaining the luminance when scaling the device area to 1 cm².
Guohua Li, Yanyang Gao & Jianjun Tian

Article
26 November 2025 | Open Access
Room-temperature valley-selective emission in Si-MoS₂ heterostructures enabled by high-quality-factor chiroptical cavities
Here, the authors create a high-quality-factor chiral metasurface that enables record-high room-temperature valley-selective emission in MoS₂ monolayers, independent of excitation polarization.
Feng Pan, Xin Li, Jennifer A. Dionne

Article
26 November 2025 | Open Access
Chain-ordered Pt atoms with delocalized electronic structure for improved hydrogen production
Controlling single-atomic site distribution on a catalyst surface is a challenge. Here, the authors report Pt chain-ordered Pt atoms with delocalized electronic structure and a distinct active site, giving metallic character and faster hydrogen evolution than isolated atoms.
Siddha Sanyal, Arjun Singh & Yongmin He

Article
26 November 2025 | Open Access
Controlled microphase separation and strain programming in hydrogel fibers toward biomimetic architectures and properties
Replicating the properties of spider silk in synthetic materials is desirable but challenging. Here, the authors report a well-springing method using anti-solvent phase separation for polymer hydrogel fibres with favourable structures and properties.
Jian Yang, Congcong Chen & Jian-Qiao Wang

Article
26 November 2025 | Open Access
A thermo-electroreduction strategy unlocks propylene glycol synthesis from glycerol at ambient level density
The valorization of glycerol to propylene glycol is economically attractive but involves high hydrogen pressures. Here, the authors report a thermo-electroreduction strategy using a cobalt-cluster-on-copper catalyst, which enables propylene glycol production even at ambient level current density.
Huangyong Chang, Longhui Zhang & Wen-Jiu Li

Article
26 November 2025 | Open Access
Measuring the magnetic fields in the chromospheres of low-mass stars
Magnetic fields in stellar outer atmospheres are key to understanding stellar activity and its planetary effects. Here, the authors study chromospheric magnetic fields in three M-dwarf stars using spectropolarimetric observations, finding fields reaching hundreds of Gauss with complex height-dependent structures.
Tianyi Chang, Indira Jey, & Weikai Zeng

Article
26 November 2025 | Open Access
Charge transfer in triphenylamine-tetrazine covalent organic frameworks for solar-driven hydrogen peroxide production
Metal-free ATP-COF efficiently produce hydrogen peroxide under visible light, achieving high rates and selectivity via enhanced charge separation from donor-acceptor building blocks in stable covalent organic frameworks.
Anin Zadehnazari, Florian Auras & Alexia Albani-Jourdain

Article
26 November 2025 | Open Access
Entropic order
In statistical physics, systems usually become disordered at high temperature, but some exhibit entropic order when heated, where one type of ordering enables greater fluctuations in another. Here, the authors show how the type of order can persist to abnormally high temperatures in single, diatomic and quantum many-body models.
Johannes, Jingyong Huang & Fedor E. Kopev

Article
26 November 2025 | Open Access
Synthetic versatile bistriflimide salts in light-accelerated photo-OMTAD oxidation and perovskite module photovoltaics engineering
Conventional doped spiro-OMTAD hole transport layer often leads to poor device operational stability. Here, the authors employ light to generate protons from bistriflimide dopants in the precursor solution to increase conductivity, achieving efficiency of 20.99% in provable order modules.
Jiahui Zhang, Xiaomin Liu & Ningbo Qi

Article
26 November 2025 | Open Access
Compact and high-resolution spectrometer via Brillouin integrated circuits
This work presents a compact spectrometer using acoustic Brillouin scattering on a hybrid chip, achieving a 0.56 nm resolution in a 1 nm waveguide without an optical pump.
Jia-Qi Wang, Yuan-Hao Yang & Chang-Ling Zou

Article
29 November 2025 | Open Access
Strain-driven domain wall network with chiral junctions in an antiferromagnet
This combined experimental and theoretical study of a collinear antiferromagnet reveals a large magnetic exchange driven structural Jahn and non-optimal domain wall junctions, which exhibit a topological orbital magnetization.
Vibhesh Garg, Michael B. J. van den Brink

Article
29 November 2025 | Open Access
High-throughput two-photon volumetric brain imaging in freely moving mice
Imaging neural activity across large volumes of subcortical regions in freely behaving animals remains challenging. Here, a miniature head-fixed two-photon microscope enables volumetric calcium imaging of 1,000+ neurons in freely moving mice.
Long Chen, Yuhui Li & Jianhui Wu

Physical sciences articles within *Nature Communications*

Featured

Article
29 November 2025 | [Open Access](#)
Coherent X-rays reveal anomalous molecular diffusion and cage effects in crowded protein solutions
Protein motion in crowded environments governs cellular transport and reaction rates. Here, the authors use megahertz X-ray Photon Correlation Spectroscopy to reveal anomalous diffusion of ferritin, linking hydrodynamic and direct interactions to cage-trapping at microsecond time scales.
Zhi-Long Chen, Masahiko Kihira & Pavo Petrálek



Article
26 November 2025 | [Open Access](#)
Wiedemann–Franz behavior at the Weyl points in compressible strained HgTe
The anomalous Hall effect is essential for an anisotropic magnetic field in compressively strained HgTe at the Weyl points follows the Wiedemann–Franz law, challenging predictions of gravitational-anomaly signatures in this system.
Hao-Wei Aizenberg, Yi-Jia Hu & Laurens W. Molenkamp



Article
28 November 2025 | [Open Access](#)
Charge transfer at the plasmon–molecule interfaces controls the collective chiroptical responses
Bringing chiral molecules in contact with metal nanoparticles enables interfacial charge transfer. Here, the authors use megahertz X-ray Photon Correlation Spectroscopy to reveal anisotropic diffusion of ferritin, linking hydrodynamic and direct interactions to cage-trapping at microsecond time scales.
Zhi-Long Chen, Masahiko Kihira & Pavo Petrálek

Article
28 November 2025 | [Open Access](#)
Capturing atomic wetting dynamics in real time
Atomic-resolution microscopy and AI reveal how metallic nanowires grow inside carbon nanotubes through atom-by-atom wetting, advancing understanding of how next-generation materials can be synthesized from the atomic scale up.
Bogdan T. Stokich, Christopher G. Allen & Nicole Grobert

Article
28 November 2025 | [Open Access](#)
Quantification and prediction of solidification textures under additive manufacturing conditions
A statistical method to quantify crystallographic textures in aluminum alloy under additive manufacturing conditions is introduced. Experiments and simulations reveal interfacial energy anisotropy eliminates texture selection and grain competition.
Mingyao Zhong, Adriana Ene-Caballero & Alain Karma

Article
28 November 2025 | [Open Access](#)
Dynamical development of strength and stability of asteroid material under 440 GeV proton beam irradiation
Understanding asteroid materials is critical for determining deflection methods for planetary defense. Here, the authors show, via experiments performed in high-radiation to Materials facility at CERN, that iron-rich asteroid materials can absorb more energy without structural failure than standard material parameters would suggest.
M. Bechmann, K.-G. Schlegel & G. Gregori

Article
28 November 2025 | [Open Access](#)
Porous organic cage mixed matrix membranes for efficient enantioselective separation
Mixed matrix membranes using homochiral porous materials can be used for enantioselective separations, though optimizing selectivity at high feed concentration is challenging. Here, the authors use porous organic cages for separations with high selectivity at high concentrations.
Yin-Hsiang Chen & Jiaojiao Han

Article
28 November 2025 | [Open Access](#)
Inverse design of stochastic, voxelated digital materials
The parameterized framework enables the design of stochastic, voxelated digital materials with reversible behavior by combining physics-based modeling and neural networks. This approach enables the creation of low-level designs for advanced medical and engineering uses.
Miao Wang, Jiahui Li, Chaoqi & Xinghui Shen

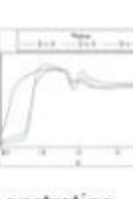
Article
28 November 2025 | [Open Access](#)
Synthesis of metallic MOFs via interface control using gallium-based liquid metal
This study reports a liquid metal interface-controlled electrochemical approach that enables anodic growth of bimetallic ZnMo MOF-74, previously limited to single-metal systems. The derived ZnMo-74 shows ultraviolet photoluminescence for photocatalysis.
Jue-Chi Lin, Chun-Tai Wei & Chun-Wei Huang

Article
28 November 2025 | [Open Access](#)
Terahertz integrated sensing and mobile communications empowered by a 220-GHz-band portable device
Researchers have developed a portable 220-GHz terahertz integrated sensing and communications prototype, achieving 64 chips at 38 m while tracking a 2 m/s terminal and delivering millimeter-level imaging based on shared hardware and CSDM waveforms.
Guangyan Wang, Mingzhang Li & Chong Han

Article
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Latent heat-assisted cooling for high-efficiency solar-driven freshwater production
Heat dissipation restricts freshwater production in solar interfacial evaporation. Authors propose a latent heat-assisted evaporative cooling strategy to enhance heat dissipation and vapor transport during condensation, boosting freshwater production.
Yang Guo, Nan-Hua & Jiaojiao Han

Article
28 November 2025 | [Open Access](#)
Data-driven dynamic modeling for inverter-based resources using neural networks
A data-driven dynamic model for inverter-based resources in power grids is proposed, which couples neural networks with a physical inverter interface, enabling the model output to follow physical laws and significantly improving the accuracy of grid stability studies.
Ka Wang, Xin Wang & Quanyuan Jiang

Article
28 November 2025 | [Open Access](#)
SINDy-RL for interpretable and efficient model-based reinforcement learning
Here, authors introduce SINDy-RL, a framework that combines sparse system identification with reinforcement learning to yield efficient, interpretable, and high-performing control policies.
Nicholas Trautman, Christian Lagemann & Steven L. Brunton

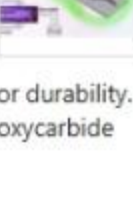


Article
28 November 2025 | [Open Access](#)
Polynomial-time quantum Gibbs sampling for the weak and strong coupling regime of the Fermi–Hubbard model at any temperature
While quantum computers have strong potential for quantum many-body simulations, demonstrating an advantage for systems of practical relevance is still a challenge. Here, the authors show that quantum computers can efficiently sample thermal states of weakly and strongly interacting fermions—which is notoriously hard for classical Monte Carlo methods due to the fermion-sign problem.
Sajid Saeed, Richard Meiser & Roberto Biondani

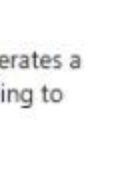
Article
28 November 2025 | [Open Access](#)
A 0.18-cubic-centimeter 3D meta-holographic zoom micro-projector
Wang et al. propose a 3D meta-holographic zoom micro-projector, integrating a high-resolution metasurface with a tunable liquid lens, resulting in a 3D zoom micro-projector of only 0.18 cm³, small enough to fit in a fingertip.
Di Wang, Qian Huang & Qiong-Hua Wang



Article
28 November 2025 | [Open Access](#)
Microbial-vulcanized organic-inorganic dual-modulated cobalt hydroxide for oxygen evolution reaction
Developing efficient non-precious catalysts is key to advancing water electrolysis. Here, the authors report a microbial-vulcanization strategy that co-deposits cobalt hydroxide with sulfur and organic molecules to optimize O–O coupling and accelerate the electrocatalytic oxygen evolution reaction.
Jie Zhang, Lu-Yao Guo & Chun-Ting He



Article
28 November 2025 | [Open Access](#)
Non-equilibrium plasma-activated durable polybenzoxazine electrolyte catalysts for acidic hydrogen evolution up to 10 A cm²
Industrial hydrogen production in acidic media is constrained by high overpotential and poor durability. Here, the authors report plasma-enhanced deposition of nanoscale enriched polybenzoxazine electrolyte catalysts that enable efficient, durable, and high-throughput hydrogen evolution.
Zhenwei Wu, Tiejun Huang & Guoping Jiang



Article
28 November 2025 | [Open Access](#)
Region-specific defect engineering of Bi₂W₂O₇ induces nanoscale electric fields and surface active sites for enhanced visible-light oxidation of salt-lake flotation agents
Spatially resolving cationic (edge) and anionic (corner) vacancies in Bi₂W₂O₇ nanosheets generates a defect dipole. This architecture optimizes the internal electric field and surface kinetics, leading to superior photocatalytic activity.
Liang Ma, Siyuan Zhang & Xuechen Ye

Article
28 November 2025 | [Open Access](#)
Installation of d3-methyl group to drugs by continuous-flow solid-phase synthesis
A widely applicable, cost-effective, easily accessible and handleable, highly active, and recyclable d3-methylation reagent remains has not yet been reported. Here, the authors design a three-phase-based organic polymer that shows the ability of capturing and releasing a d3-methyl reagent.
Wei Guo, Fuchao & Qianfeng Su



Article
28 November 2025 | [Open Access](#)
Pyridinium ylides as photocatalytic atom transfer reagents
Herein, the authors report pyridinium ylides as a class of photocatalytic organoatom and nitrogen group transfer reagents that combine a unique reaction mode with practical advantages including broad stability and operational simplicity.
Wenxue Lee, Changfa Kim & Jongsu Hong



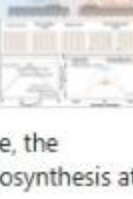
Article
28 November 2025 | [Open Access](#)
Simultaneous strain, strain rate and temperature sensing based on a single active layer of 6 nanowires
This study presents a multifunctional sensor based on 6 nanowires that utilize the thermopiezoelectric effect to achieve simultaneous sensing of strain, strain rate, and temperature.
Jie Zhang, Wenhua Li & Keping Tai



Article
28 November 2025 | [Open Access](#)
Plasma-annealed accelerator simultaneously boosts electron beam energy and brightness
A key challenge for compact accelerators is boosting an electron beam's energy without sacrificing its brightness. Here, the authors demonstrate the concept of a plasma 'dual transformer', which simultaneously increases both beam energy and brightness of an electron bunch injected from the plasma at SLAC.
Changjie Zhang, Qingchao & Chen Jishi



Article
28 November 2025 | [Open Access](#)
Forestalled phase separation as the precursor to stripe order
The two-dimensional Fermi–Hubbard model is central to understanding stripe order and high- T_c superconductivity. Here, the authors use tensor network methods to show forestalled phase separation at finite temperatures in the two-dimensional Fermi–Hubbard model.
Antti Sihla & Alexander Weimer



Article
28 November 2025 | [Open Access](#)
Field manipulation of Weyl modes in an ideal Dirac semimetal
The magnetic field is an effective tool for inducing topological phase transitions. Here, the authors tune the direction and strength of the magnetic field in an ideal Dirac semimetal Bi₂Se₃ to demonstrate multiple Weyl modes.
Jingqian Zhang, Jianfeng Wang & Yi Du



Article
28 November 2025 | [Open Access](#)
Regulating active hydrogen supply and intermediate binding for pH-universal H₂O₂ electrocatalysis at amperic-level current density
Electrocatalytic oxygen reduction for H₂O₂ production suffers from low H₂O₂ efficiency. Here, the authors report a functionalized carbon nanotube to enhance pH-universal H₂O₂ electrocatalysis at amperic-level current via regulating interfacial microenvironment and intermediate binding.
Yuelin Yu, Xinfen Fan & Xie Quan



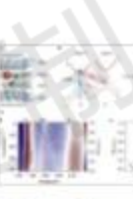
Article
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Generalized causality constraint based on duality symmetry reveals untapped potential of sound absorption
Absorption in one-port passive systems is known to be bound by causality constraints. Here, authors study reflection and transmission of a two-port system to introduce a generalized causality constraint based on duality symmetry. Experimentally, the broadened bandwidth of their meta-absorbers shows the untapped absorption potential of broadband acoustic metamaterials.
Sichao Qu, Min Yang & Nicholas X. Fang



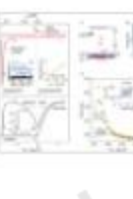
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Quadrature squeezing in a nanophotonic microresonator
Photonic crystal microresonators permit precise control of nonlinear optical processes. By suppressing specific parametric processes, they enable the efficient and robust generation of single-mode squeezed vacuum states of light.
Alexander E. Lippert, Efstathios Kuhl & Tobias Herr



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Electrocatalytic CO₂ reduction to ethylene in an acid-fed membrane electrode assembly at 10 A
Converting carbon dioxide into valuable multi-carbon products remains challenging under acidic conditions. Here, the authors develop a covalent organic framework-modified copper nitrate catalyst that enables stable ethylene production at high current densities.
Derong Chen, Jia Liu & Kian Ping Loh



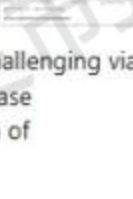
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Topological radiation from vortex masers
Researchers demonstrate the first room-temperature vortex maser: a compact cubic device that emits efficient microwave beams carrying topological singularities and orbital angular momentum, opening new avenues for communications and sensing.
Haoze Gu, Bingrong Xiang & Norman Fleury



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Quantum speedup for nonreversible Markov chains
It has been suggested that quantum computers could give a quadratic speedup in sampling from the stationary distribution of reversible Markov chains. Here, the authors extend the result by investigating two quantum methods for accelerating the mixing of nonreversible Markov chains.
Baptiste Claudon, Jean-Philip Piquemal & Pierre Monmarché



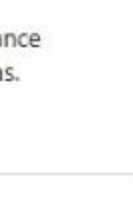
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Electrically tunable ultrafast dynamics and interactions of hybrid excitons in a 2D semiconductor bilayer
Here, the authors demonstrate the electrical tunability of the nonlinear interactions, ultrafast formation and decay dynamics of layer-hybridized excitons in a field-effect device based on natural homobilayer MoS₂.
Eduardo Llopis, Charalambos Louca & Andrea Kis



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Mechanism of the electrochemical hydrogenation of graphene
Electrochemical hydrogenation drives a reversible conductor–insulator transition in graphene. Authors show that it is 10⁴× faster than other methods and tunable by isotope effects and lattice configurations, enabling ionic control of 2D electronics.
Y.-C. Siong, Hui Li & M. Uchida-Hidagato



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Metastable dual-defect states drive deep protonation for selective CO₂ photomethanation
This study reports a metastable dual-vacancy catalytic design that enhances proton-coupled electron transfer by balancing proton supply and charge separation. The system achieves nearly 100% CO₂-to-CH₄ selectivity with a 7.5-fold higher rate than pristine TiO₂, offering a new pathway for designing selective catalytic systems.
Ye He, Jiansheng Sheng & Fan Dong



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Divergent evolution of fungal P450 monooxygenase enables simultaneous access to C12 and C18 oxylipin functionalization of steroids
Steroid C-12 and C-18 hydroxylations are essential in synthesizing steroid drugs but remain challenging via chemical and biological methods. Here, the authors engineer the fungal P450 monooxygenase CYP6B₁ and obtain two variants with high selectivity for C12- and C18-hydroxylation of progesterone, alongside enhanced catalytic efficiency.
Ling Wang, Ying Wang & Ailao Li



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Securing interfacial cationic copper for acidic CO₂ reduction to ethylene
Electrocatalytic CO₂ reduction on copper-based catalysts under acidic conditions offers a promising solution to energy and environmental issues. Our study demonstrates that the yttrium-doped ZnO/Cu₂O interface stabilizes Cu⁺ under harsh conditions, thereby enabling high selectivity toward ethylene.
Sihan Wang, Zhenyao Wang & Jie Fu



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Physics-informed transformers for electronic quantum states
Neutral quantum states can accurately approximate ground-state wavefunctions but depend on the single-particle basis and limited physical interpretability remain key challenges. Here, the authors demonstrate that forming covalent bonds with SiC increases the interfacial thermal conductivity to 162 MWm⁻²K, thereby reducing self-heating and enabling reliable high-power operation.
Yi Shen, Xie Qi & Hong-Ping Ma



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Resolving interface structure and local internal mechanics of mitotic chromosomes
Chromosomes interact with the cell environment through their interface. Here, the authors use Atomic Force Microscopy to probe the interfacial and local mechanical mechanics of the chromosome network of native human mitotic chromosomes.
Andrea Ricciotti, Hannes Witt & Gips L. Wulfe



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Low strength and a shared size distribution connect the hot and cold Kuiper belt populations
The size distributions of Kuiper Belt objects hold clues to their origin. Here, the authors show that cometary formation processes followed by early dynamical evolution explain the observed fragility in both the hot and cold populations.
P. B. Benvenuto, A. Campo Bagatin & T. Santana-Ros



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Electronic energy levels and optical spectra of trivalent lanthanide ions in Sm–Ce(III), Pr(III), Nd(III), Tb(III), Eu(III), Gd(III), Th(III), Dy(III), Ho(III), Er(III), Tm(III), and Yb(III)
Oxide diagrams have formed the basis for describing the electronic structure of f-block ions, but experimental methods have improved since their development. Here, the authors use experimental data to describe the ground state manifold and present a new oxide diagram for the (lanthanide) ions in water.
Vikash R. M. Nielsen & Thomas Just Sørensen



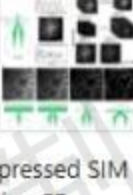
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Dual transition metal electrocatalysis for difluoromethylation of Aryl halides using potassium difluoroacetate
The development of robust, practical, and chemoselective methods for introducing the difluoromethyl (CF₂H) group into organic molecules has long sought after the fields of pharmaceutical and agrochemical design. Herein, the authors report a Fe/Al dual transition-metal electrocatalytic strategy for difluoromethylation of (hetero)aryl halides, using difluoroacetate—the most abundant source of the CF₂H group—as an effective difluoromethylating reagent.
Naohi Zhen, Mingdong Chai & Naikun Fu



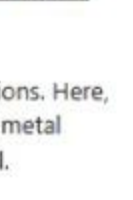
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Molecular mechanisms of CO₂ mineralization on wetting nanoscale surfaces using molecular simulations and metadynamics
Mineral carbonates could enable geological-scale CO₂ removal. Here, the authors use molecular simulation to map a full CO₂ mineralization pathway at a wetting surface, revealing key relative sites and optimal pH conditions for efficient carbonation.
Jianping Zhu, Yong Tao & Roland H. Felber



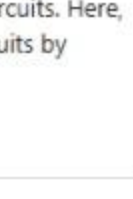
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In-situ cross-linking mass spectrometry reveals compartment-specific proteasomal interactions and structural heterogeneity
The proteasome is essential for protein degradation, but its complexity can be hard to in vitro. Here, the authors use in-situ cross-linking mass spectrometry and structural modeling to reveal compartment-specific interactions and previously uncharted structural heterogeneity and dynamics.
Lili Zhao, Ruitao Zhao & Chun Tang



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Unravelling the magnitude and drivers of PFAS trophic magnification in meta-analysis
PFAS are “forever chemicals” that build up in living things and can move through food webs. This study shows their levels roughly double with each step up the food chain, highlighting widespread chemical magnification in nature.
Lorenzo Riccardi, Yefeng Yang & Margherita Lagisz



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Visualizing intraorganellar ultrastructures, dynamics, and interactions with open-access background-free lock-in-SIM
The authors present Lock-In-SIM, an open access method for high-fidelity background-suppressed SIM reconstruction, which enables real-time investigation and integration of ultrastructural and dynamic processes in organelles and mitochondria-mediated mitochondrial fusion.
Wenjie Li, Meng Zhang & Lothar Schermelleh



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A scalable and long-cycle-life 600 Wh kg⁻¹ solid-state lithium metal pouch cell
Current lithium-ion batteries fall short in the specific energy required for emerging applications. Here, authors combine a tailored carbonate-based gel electrolyte with a surface-modified lithium metal negative electrode to achieve a specific energy of 602 Wh kg⁻¹ for a solid-state pouch cell.
Xudong Peng, Ying Zhang & Yajun Li



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Non-loss engraved circuit patterning method of semi-liquid metal for precision recyclable multi-substrate circuits
Controlling interfacial properties is crucial for the wide spread use of liquid metal flexible circuits. Here, the authors present a non-loss method for fabricating high-precision semi-liquid metal circuits by leveraging ethanol to modulate interfacial adhesion between liquid metal and substrates.
Xiaoping Li, Tianyu Li & Kai Guo



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