Volume 21 Issue 6, June 2025

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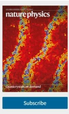

Quasicrystals on demand

Two-dimensional dodecagonal quasicrystals are reversibly assembled from single-component microspheres. The quasi-repetitive images represent the transition from an initially hexagonal to a quasicrystalline lattice (left to right and top to bottom). The magnitude of the local dodecahedral bond orientational order that characterizes the 12-fold symmetry goes from 1 (red) to 0 (blue) and back to 1 again.

See Yan Gao et al.

Image: Gao Yan, David Marr, and Ning Wu, Colorado School of Mines; Cover design: Lanxia Wu/ GoBranch

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Triple jump forward

This month, we publish three articles reporting breakthroughs in different areas of quasicrystal research.

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Student interactions with generative AI

Students are turning to generative AI chatbots like ChatGPT to support their physics learning. Here, I examine one student's interactions with ChatGPT on an exam recuperation assignment and the student's reflections on the process.

W. Brian Lane

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Women scientists through the ages

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Entanglement meets artificial intelligence in quantum sensors

The high precision of atomic sensors can be further enhanced by quantum correlations between atoms prepared in an entangled state through the use of artificial intelligence.

Alice Sinatra

News & Views
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Watch them grow

Quasicrystals were discovered by chance about 40 years ago, and it has largely been a matter of luck to find new ones since. Now, an approach has been found to grow colloidal quasicrystals by turning a dial while directly observing them with an optical microscope.

Martin Dulle

News & Views
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Scooping for ground states

More than a hundred quasicrystals have been found so far, but their thermodynamic stability has remained an open question. Extrapolating density functional theory calculations of ever larger clusters now show that two alloys are indeed ground states.

Peter Brommer

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Take protons for a ride

Stefanie Reichert

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Magmatic intrusions in real time

Lishu Wu

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A geometric incompatibility by any other name

David Abergel

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Research Briefings

Research Briefing
26 May 2025

Perturbations in out-of-equilibrium quantum fluids diffuse rather than propagate

Symmetry breaking is routinely observed in isolated systems, where perturbations propagate through the system. For out-of-equilibrium systems, however, perturbations are predicted to diffuse; and this key signature of spontaneous symmetry breaking has now been observed in a polariton quantum fluid.

Research Briefing
06 May 2025

Electron–phonon coupling resolved by phonon mode and electron energy

A two-dimensional spectroscopic technique to probe the strength of electron–phonon coupling has the capability to simultaneously resolve the phonon mode and the electron transition energy — and is bringing fresh insight into the complex interactions of phonons and electrons in a range of materials.

Research Briefing
06 Apr 2025

Bacterial second messengers achieve extraordinary signal capacity

Second messengers are intracellular signaling molecules that relay environmental changes and prompt cellular responses. Through an information-theory framework coupled with quantitative experiments, the second-messenger molecule cdiGMP, in the bacterium *Pseudomonas aeruginosa*, is shown to achieve information transmission rates of up to 40 bits per hour.

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Review Articles

Review Article
06 Jun 2025

The positron arm of a plasma-based linear collider

The status of plasma-based acceleration of electrons and positrons is discussed, with a focus on developing the positron arm of a plasma-based electron–positron linear collider.

Chandrashekhar Joshi, Warren B. Mori & Mark J. Hogan

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Articles

Article
Open Access
02 May 2025

Strongly interacting Meissner phases in large bosonic flux ladders

The quantum simulation of driven, strongly correlated phases at large scales is challenging, primarily due to detrimental heating effects. Now, a large-scale interacting Meth-Meissner phase has been realized in a neutral-atom quantum simulator.

Alexander Impertro, Seungjung Huh, … Monika Aidelsburger

Article
Open Access
11 Apr 2025

Continuous recoil-driven lasing and cavity frequency pinning with laser-cooled atoms

Experiments with cold atoms in optical cavities are often limited to discontinuous operation due to reloading requirements. Now, continuous lasing is demonstrated with strontium atoms in a ring cavity, stabilized by atom loss mechanisms.

Vera M. Schäfer, Zhiqing Niu, … James K. Thompson

Article
08 Apr 2025

Concurrent spin squeezing and field tracking with machine learning

Simultaneous spin squeezing and the detection of dynamic fields is challenging as entanglement generation and signal interrogation often interfere. An experiment now demonstrates stable spin squeezing and field tracking in a hot atomic ensemble.

Junlei Duan, Zhiwei Hu, … Yanhong Xiao

Article
15 Apr 2025

Hamiltonian engineering of collective XYZ spin models in an optical cavity

Spin models that can be emulated by quantum simulators are usually restricted to systems with conserved total magnetization. The tuning of photon-mediated interactions between atoms in a cavity enables the implementation of more general models also useful for quantum sensing tasks.

Chengyi Luo, Haoping Zhang, … James K. Thompson

Article
02 May 2025

Observation of the diffusive Nambu–Goldstone mode of a non-equilibrium phase transition

Gapless modes emerging from non-equilibrium phase transitions are predicted to diffuse rather than propagate as sound waves. Now, the diffusion of these modes and their suppression under symmetry breaking are confirmed in a polariton condensate.

Ferdinand Claude, Maxime J. Jacquet, … Alberto Bramati

Article
22 Apr 2025

Scalable microwave-to-optical transducers at the single-photon level with spins

Converting photons from one frequency range to another uses nonlinear effects that are often weak. Strong nonlinearities in rare-earth-ion-doped crystals have now been used to perform microwave-to-optical transduction at the single-photon level.

Tian Xie, Rikuto Fukumori, … Andrei Faraon

Collection: Harnessing quantum: progress towards real world applications of quantum technologies

Article
15 Apr 2025

Impact of impurities on crystal growth

Crystallization processes are influenced by the presence of impurities. Colloid experiments now reveal two distinct types of growth mode that depend on the extent to which a crystallizing system can remove impurity particles from its growth front.

Qining Gao, Huang Fang, … Peng Tan

Article
Open Access
14 Apr 2025

Ultrafast room-temperature valley manipulation in silicon and diamond

Control over electron populations in different conduction band minima in semiconductors can be used to store and process information. Now the ultrafast optical manipulation of such electrons at room temperature has been demonstrated in silicon and diamond.

Adam Gindl, Martin Čmel, … Martin Kozák

Article
Open Access
08 Apr 2025

Mode-resolved, non-local electron–phonon coupling in two-dimensional spectroscopy

Probing electron–phonon matrix elements in bulk materials is difficult. Now, an all-optical experimental approach is demonstrated that extracts phonon-mode- and electron-energy-resolved electron–phonon matrix elements in the bulk.

Sheng Gu, Vishal K. Sharma, … Hyejae Kim

Article
07 Apr 2025

Observation of polarization density waves in $SrTiO_3$

Despite exhibiting ferroelectric features, $SrSO_3$ fails to display long-range polar order at low temperatures due to quantum fluctuations. An ultrafast X-ray diffraction experiment now probes polar dynamics of this material at the nanometre scale.

Gal Orenstein, Viktor Krapivin, … Mariano Trigo

Article
31 Mar 2025

Direct observation of colloidal quasicrystallization

Quasicrystals, which lack translational symmetry but display rotational order, are difficult to make. Now an assembly method for the fabrication of colloidal quasicrystals that offers a high degree of controllability and reversibility is reported.

Yan Gao, Brennan Sprinkle, … Ning Wu

Article
Open Access
14 Apr 2025

Observation of antiferromagnetic order in a quasicrystal

Quasicrystals lack translational symmetry but display rotational order. Whether antiferromagnetic order can exist in quasicrystals has been unclear. Now, long-range antiferromagnetic order is shown in the icosahedral quasicrystal $Au_{66}In_{20}Eu_{14}$.

R. Tamura, T. Abe, … T. J. Sato

Article
13 Jun 2025

Quasicrystal stability and nucleation kinetics from density functional theory

Traditionally, density functional theory could not describe quasicrystals as they lack translational symmetry. An ab initio approach now establishes that the quasicrystalline structures of $Sc_{Z_{13}}$ and $YbCd_{6.1}$ are true ground states.

Woohyeon Baek, Sambit Das, … Wenhao Sun

Article
22 Apr 2025

Skyrmion bags of light in plasmonic moiré superlattices

Skyrmion bags—textures comprising multiple skyrmions contained within a larger skyrmion—have been reported in several condensed matter systems. Now an optical analogue of these structures has been observed in plasmonic moiré superlattices.

Julian Schwab, Alexander Neuhaus, … Harald Giessen

Article
04 Apr 2025

Shape-recovering liquids

Placing particles at the interface between immiscible fluids usually enhances emulsification. However, now it is shown that if the particles are ferromagnetic, emulsification is suppressed and a non-planar recoverable interfacial shape develops.

Anthony Kaykh, Joseph D. Paulsen, … Thomas P. Russell

Article
Open Access
18 Apr 2025

Interplay of actin nematodynamics and anisotropic tension controls endothelial mechanics

Blood flow through a vessel deforms vessel walls. Cells lining these walls sense the changes in pressure as blood flows and reorient their actin fibres in the direction of tangent tension.

Claire A. Desjardin, Nicolas Cuny, … Guillaume Salbreux

Article
27 Mar 2025

Quantifying second-messenger information transmission in bacteria

Bacterial second messengers carry signals from the environment to target proteins in the cell. Now the associated information transmission capacity is quantified and the optimal frequency to maximize it is determined.

Jianzi Xiong, Liang Weng, … Fan Jin

Article
14 Apr 2025

Concurrent slow and fast frictional ruptures in laboratory earthquakes

Frictional motion of bodies in contact is facilitated by ruptures at their interface. Experiments with laboratory earthquakes now reveal that frictional ruptures at an interface can happen at both slow and fast timescales.

Songlin Shi & Jay Fineberg

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Amendments & Corrections

Author Correction
22 May 2025

Author Correction: Observation of polarization density waves in $SrTiO_3$

Gal Orenstein, Viktor Krapivin, … Mariano Trigo

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Measure for Measure

Measure for Measure
13 Jun 2025

Earth's position in the Universe

From determining sea-level changes at the millimetre-level to navigating through the streets of Gothenburg, Karine Le Bail discusses the need for precise positioning within well-defined 3D terrestrial and celestial reference frames.

Karine Le Bail

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