Volume 21 Issue 8, August 2025

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Helpful entanglement

Simulated and ideal quantum state evolutions, depicted as diverging curves, converge within entangled regions. Qi Zhao and co-workers reveal that quantum entanglement, typically viewed as an obstacle to classical simulation, can instead enhance the accuracy and efficiency of quantum simulations.

See Qi Zhao et al.

Image: Yutong Yang, Yuqi Ma, Harbin Institute of Technology, Shenzhen. Cover design: Lacine Mac Gabhann

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Fractional computing

We highlight how an abstract piece of condensed-matter physics — the fractional quantum Hall effect — may be ideally placed to implement quantum computers.

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How to soothe the turmoil in the field of pressure-induced superconductivity in the hydrides

A crucial issue in condensed-matter physics is the assessment of superconducting diamagnetism in highly compressed hydrides. We propose a suitable reference sample that can be used to gain more consensus.

Liling Sun, Qi Wu ... Ho-kwang Mao

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Thesis

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We never thought alone

Mark Buchanan

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News & Views

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09 Jul 2025

Ytterbium dopants for quantum simulation

Understanding and controlling many-body interactions is essential for advancing quantum science. A crystal containing millions of strongly interacting ytterbium ion dopants has now been used to simulate complex quantum many-body phenomena.

Diana Serrano

News & Views
10 Jul 2025

A model spin liquid

It is thought that a resonating valence bond state can form in certain correlated systems. However, this behaviour is predicted by only a few realistic models. Now it has been shown that this phase emerges in an experimentally relevant model.

Didier Poilblanc

News & Views
06 Aug 2025

Twisted topology visualized in real space

Microscopic details of the interplay between correlated electron states and topology are visualized in twisted transition metal dichalcogenide bilayers using scanning tunnelling microscopy and spectroscopy.

Adina Luican-Mayer

News & Views
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Intertwined orders in a quantum material

Symmetry-protected topological orders are often in competition with electronic correlations that tend to induce orders with broken symmetry. Now, a quantum material is shown to exhibit correlation-driven tuneable exotonic instabilities intertwined with symmetry-protected topological orders.

Giacomo Mazza

News & Views
18 Jun 2025

From actin to action

Cells undergo structural rearrangements to enable migration and changes in morphology. A study using reconstituted actomyosin revealed that these earthquake-like events are driven by F-actin organization and active stress generation.

Yu Shi

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Beef fringes and dimples

Elizaveta Dubrovina

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Research Briefings

Research Briefing
07 Aug 2025

Frustrated electron motion arising from the orbital configuration in a layered metal

Electron hopping on geometrically frustrated lattices leads to unusual, correlated phenomena, but materials whose structures match such lattices are rare. Now, in $PbZnTe_2$, frustrated electron motion is shown to emerge from the atomic orbital configuration, rather than the lattice geometry — which means the search space for unusual electronic structures and correlated behaviour can be broadened to materials with simpler, more common structures.

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Articles

Article
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11 Jun 2025

Ultrasensitive single-ion electrometry in a magnetic field gradient

Trapped ions are promising for electrometry but limited by their weak intrinsic spin coupling to electric fields. Now it is shown that using a magnetic field gradient enhances sensitivity and enables precise measurements across subhertz to kilohertz frequencies.

F. Bonus, C. Knapp ... W. K. Hensinger

Article
09 Jul 2025

Quantum thermalization and Floquet engineering in a spin ensemble with a clock transition

Using Floquet engineering, an ensemble of ytterbium-171 ions in an yttrium orthovanadate host crystal provides a platform for studying the dynamics of different quantum many-body models, including the realization of a time-crystalline phase.

Mi Lei, Rikuto Fukumori ... Andrei Faraon

Article
19 Jun 2025

Neutron scattering and thermodynamic evidence for emergent photons and fractionalization in a pyrochlore spin ice

Quantum spin-ice phases are predicted to have emergent gauge fields and fractionalization. Neutron scattering and thermodynamic measurements of the quantum spin-ice candidate $Ce_2Zr_2O_7$ show features consistent with these predictions.

Bin Gao, Felix Desrochers ... Pengcheng Dai

Article
Open Access
29 May 2025

A resonant valence bond spin liquid in the dilute limit of doped frustrated Mott insulators

The concept of resonant valence bond phases has inspired many areas of condensed matter physics, but few realistic models have been identified. Now an analytical solution of such a phase has been found for pyrochlore and related lattices.

Cecile Gilituin, Antonio Sirkaj ... Claudio Castelnovo

Article
01 May 2025

Experimental signature of layer skyrmions and implications for band topology in twisted WSe_2 bilayers

Evidence is shown for a skyrmion-like texture in the layer polarization of the electronic wavefunctions of a twisted two-dimensional material. This provides support for theories that link this spatial texture to the topological properties.

Fan Zhang, Nicolás Morales-Durán ... Chih-Kang Shih

Article
01 May 2025

Microscopic signatures of topology in twisted $MoTe_2$

The topological properties of twisted bilayer $MoTe_2$ are thought to stem from a spatial texture in the layer polarization of the electronic wavefunctions. This polarization is now measured using scanning tunnelling microscopy.

Ellis Thompson, Kang Tou Chu ... Matthew Yankowitz

Article
09 Jun 2025

Spin-selective magneto-conductivity in WSe_2

Mechanisms for generating spin-polarized currents may be helpful for applications. Now one such mechanism that uses the unusual Landau-level spectrum of WSe_2 under a strong magnetic field is demonstrated.

En-Min Shih, Qianhui Shi ... Cory R. Dean

Article
26 Jun 2025

Tunable interplay between light and heavy electrons in twisted trilayer graphene

Graphene multilayers can host heavy electrons in flat bands alongside light electrons in Dirac cones. Local probes now reveal that a finite Dirac electron population persists at the Fermi level while correlated states form in the flat bands.

Andrew T. Pierce, Yongjing Xie ... Amir Yacoby

Article
Open Access
17 Jun 2025

Emergent exchange-driven giant magnetoelastic coupling in a correlated itinerant ferromagnet

Magnetostructural changes are usually small and driven by spin–orbit coupling. Now, electron–lattice coupling enhanced by exchange interactions is shown to produce giant magnetostriction in a correlated ferromagnet.

Caroline A. Marques, Luke C. Rhodes ... Peter Wahl

Article
11 Jul 2025

Topological excitonic insulator with tunable momentum order

Experimental systems in which non-trivial topology is driven by spontaneous symmetry breaking are rare. Now, topological gaps resulting from two excitonic condensates have been demonstrated in a three-dimensional material.

Md Shafayat Hossain, Zi-Jia Cheng ... M. Zahid Hasan

Article
07 Aug 2025

Frustrated electron hopping from the orbital configuration in a two-dimensional lattice

Electron hopping in geometrically frustrated lattices can result in a rich variety of unusual behaviours. Now, the orbital arrangement in a van der Waals metal with a non-frustrated, primitive lattice is found to show similar effects.

Aravind Devarakonda, Christie S. Koay ... Xavier Roy

Article
27 Jun 2025

Dynamic phase transition in $1T\text{-}TaS_2$ via a thermal quench

The photoinduced hidden metallic state in $1T\text{-}TaS_2$ has so far been stabilized only at cryogenic temperatures. Now it is shown that accessing an additional mixed-phase long-lived metastable state can stabilize the hidden phase at higher temperatures.

Alberto de la Torre, Qiaochu Wang ... Kemp W. Plumb

Article
10 Jul 2025

First-principles diagrammatic Monte Carlo for electron–phonon interactions and polaron

Diagrammatic Monte Carlo calculations accurately describe polarons in different theoretical models. Now, integrating this with accurate first-principles calculations can describe the ground-state and dynamic properties of polarons in real materials.

Yao Luo, Jinsoo Park & Marco Bernardi

Article
29 Jun 2025

Observation of the transverse Thomson effect

When a charge current, a temperature gradient and a magnetic field are applied orthogonally to each other, a conductor is expected to heat or cool. This so-called transverse Thomson effect has now been observed for a bismuth–antimony alloy.

Atsushi Takahagi, Takamasa Hirai ... Ken-ichi Uchida

Article
18 Jun 2025

Feedback between F-actin organization and active stress governs criticality and energy localization in the cell cytoskeleton

Self-organized criticality can occur in cellular systems, but its origins remain unclear. Now it is shown that cytoskeletal criticality is influenced by the F-actin architecture and myosin active stress.

Zachary Gao Sun, Nathan Zimmerberg ... Michael Murrell

Article
Open Access
26 Jun 2025

Membraneless protocell confined by a heat flow

It is unclear how self-compartmentalization emerged in prebiotic conditions. Now it is shown that a temperature gradient in a confined space can bring the core components of a cell together.

Alexander Florioni, Noël Yeh Martin ... Dieter Braun

Article
20 Jun 2025

Intercellular flow dominates the poroelasticity of multicellular tissues

Tissues are usually modelled as viscoelastic materials. Now it is shown that intercellular fluid flow, rather than viscoelastic behaviour, dominates the immediate mechanical response of tissues.

Fan Liu, Bo Gao ... Ming Guo

Article
16 Jun 2025

Experimental demonstration of breakeven for a compact fermionic encoding

Digital quantum simulations of fermionic models have so far been based on the Jordan–Wigner encoding, which is computationally expensive. An alternative and more efficient encoding scheme is now demonstrated in a trapped-ion quantum computer.

Ramil Nigmatullin, Kevin Hémery ... Henrik Dreyer

Article
Open Access
05 Jun 2025

Experimentally probing Landauer's principle in the quantum many-body regime

Landauer's principle connects entropy and energy, dissipation in non-equilibrium processes. An experiment now uses this principle to measure entropy production in a Bose gas to resolve contributions from correlations and dissipation.

Stefan Amiet, Mohammadamin Tajik ... Jens Eisert

Article
Open Access
28 Jul 2025

Predicting topological entanglement entropy in a Rydberg analogue simulator

A numerical approach capable of simulating large-scale Rydberg atom quantum systems suggests that protocols for preparing topological states can produce experimental signatures of these states without reaching a topological phase.

Linda Mauron, Zakari Denis ... Giuseppe Carleo

Article
14 Jul 2025

Entanglement accelerates quantum simulation

Large quantum systems with high entanglement are difficult to simulate with classical methods, but now it is shown that entanglement may be beneficial for quantum simulations.

Qi Zhao, You Zhou, Bi Andrew M. Childs

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Amendments & Corrections

Publisher Correction
Open Access
07 Jul 2025

Publisher Correction: Absence of heat flow in $\nu = 0$ quantum Hall ferromagnet in bilayer graphene

Ravi Kumar, Saurabh Kumar Srivastav ... Anindya Das

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Measure for Measure

Measure for Measure
11 Aug 2025

Metrology supports product safety

Knowledge gained by combining measurements and simulations leads to increased confidence in the safety of products, as Louise Wright explains.

Louise Wright

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