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1 - 20 of 2,887 Results

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July - September 2024

Category

- [x] ALL
- [ ] Open Access (2,874)
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Article Type

- [x] ALL
- [ ] Article (2,794)
- [ ] Erratum (61)
- [ ] Editorial (18)
- [ ] Comment (4)
- [ ] Perspective (4)
- [ ] Reply (3)
- [ ] Announcement (2)
- [ ] Retraction (1)

Unitary k-Designs from Random Number-Conserving Quantum Circuits

Sumner N. Hearth, Michael O. Flynn, Anushya Chandran, and Chris R. Laumann

Phys. Rev. X **15**, 021022 (2025) - Published 21 April, 2025

Symmetry-constrained random quantum circuits generate randomness more slowly than unconstrained ones, following a diffusive process. This finding reveals how conservation laws can impact quantum simulation and computation.

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Pulling Order Back from the Brink of Disorder: Observation of a Nodal-Line Spin Liquid and Fluctuation Stabilized Order in K_2IrCl_6

Qiaochu Wang, Alberto de la Torre, Jose A. Rodriguez-Rivera, Andrey A. Podlesnyak, Wei Tian, Adam A. Aczel, Masaaki Matsuda, Philip J. Ryan, Jong-Woo Kim, Jeffrey G. Rau, and Kemp W. Plumb

Phys. Rev. X **15**, 021021 (2025) - Published 21 April, 2025

The discovery of a nodal-line spin-liquid phase in a frustrated magnet shows how fluctuations in such materials can act counterintuitively to protect an ordered magnetic moment.

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Theory of Free Fermions Dynamics under Partial Postselected Monitoring

Chun Y. Leung, Dganit Meidan, and Alessandro Romito

Phys. Rev. X **15**, 021020 (2025) - Published 18 April, 2025

Complex quantum phase transitions can emerge from just a few measurement histories, an insight that could simplify exploration and control of monitored quantum systems.

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A Quantum Critical Line Bounds the High Field Metamagnetic Transition Surface in UTe_2

Z. Wu, T. I. Weinberger, A. J. Hickey, D. V. Chichinadze, D. Shaffer, A. Cabala, H. Chen, M. Long, T. J. Brumm, W. Xie, Y. Ling, Z. Zhu, Y. Skourski, D. E. Graf, V. Sechovský, M. Vališka, G. G. Lonzarich, F. M. Grosche, and A. G. Eaton

Phys. Rev. X **15**, 021019 (2025) - Published 17 April, 2025

High-field superconductivity in UTe_2 is linked to a continuous quantum critical line rather than a single quantum critical point. The findings suggest that metamagnetic fluctuations play a key role in the observed high-field superconductivity.

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Electronic Nematicity in Interface Superconducting $LAO/KTO(111)$

X. B. Cheng, M. Zhang, Y. Q. Sun, G. F. Chen, M. Qin, T. S. Ren, X. S. Cao, Y. W. Xie, and J. Wu

Phys. Rev. X **15**, 021018 (2025) - Published 16 April, 2025

The discovery of nematic superconductivity in a lanthanum aluminate/potassium tantalate heterostructure suggests a deep connection between electronic nematicity and unconventional superconductivity.

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Accuracy Guarantees and Quantum Advantage in Analog Open Quantum Simulation with and without Noise

Vikram Kashyap, Georgios Styliaris, Sara Mouradian, J. Ignacio Cirac, and Rahul Trivedi

Phys. Rev. X **15**, 021017 (2025) - Published 16 April, 2025

Quantum simulators can efficiently solve dissipative many-body problems that are intractable for classical computers, even with noise, thus establishing a robust quantum advantage for studying open quantum systems.

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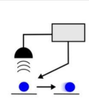

Topology of Discrete Quantum Feedback Control

Masaya Nakagawa and Masahito Ueda

Phys. Rev. X **15**, 021016 (2025) - Published 15 April, 2025

A new class of dynamical topological phases emerges in quantum systems where measurements and feedback control shape evolution. This discovery enables noiseresistant quantum control and advances the study of topology in open quantum systems.

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Deep-Learning Generation of High-Resolution Images of Live Cells in Culture Using Tri-Frequency Acoustic Images

Natsumi Fujiwara, Midori Uno, Hiroki Fukuda, Akira Nagakubo, Shao Ying Tan, Masahiro Kino-oka, and Hirotsugu Ogi

Phys. Rev. X **15**, 021015 (2025) - Published 15 April, 2025

A new method for obtaining high-resolution images of cells from low-resolution ultrasound data enables longer, noninvasive monitoring of organisms.

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From Existing and New Nuclear and Astrophysical Constraints to Stringent Limits on the Equation of State of Neutron-Rich Dense Matter

Hauke Koehn, Henrik Rose, Peter T. H. Pang, Rahul Somasundaram, Brendan T. Reed, Ingo Tews, Adrian Abac, Oleg Komoltsev, Nina Kunert, Aleksi Kurkela, Michael W. Coughlin, Brian F. Healy, and Tim Dietrich

Phys. Rev. X **15**, 021014 (2025) - Published 14 April, 2025

For neutron stars, a combination of nuclear experiments, astrophysical data, and gravitational waves narrows the uncertainty of radii measurements to 0.5 km and predicts a maximum mass of about 2.3 solar masses.

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Classification of Joint Quantum Measurements Based on Entanglement Cost of Localization

Jef Pauwels, Alejandro Pozas-Kerstjens, Flavio Del Santo, and Nicolas Gisin

Phys. Rev. X **15**, 021013 (2025) - Published 14 April, 2025

A powerful framework allows scientists to understand and classify joint quantum measurements—procedures essential for many quantum technologies.

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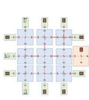

Digital Discovery of Interferometric Gravitational Wave Detectors

Mario Krenn, Yehonathan Drori, and Rana X Adhikari

Phys. Rev. X **15**, 021012 (2025) - Published 11 April, 2025

AI-driven design of gravitational wave detectors uncovers approaches that surpass current plans, potentially boosting sensitivity more than tenfold.

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Control of Solid-State Nuclear Spin Qubits Using an Electron Spin-1/2

Hans K. C. Beukers, Christopher Waas, Matteo Pasini, Hendrik B. van Ommen, Zarije Ademi, Mariagrazia Iuliano, Nina Codreanu, Julia M. Brevoord, Tim Turan, Tim H. Taminiau, and Ronald Hanson

Phys. Rev. X **15**, 021011 (2025) - Published 11 April, 2025

Improved methods for using electron spins to sense and control nuclear spins could benefit many quantum technologies.

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Spin-Stripe Order Tied to the Pseudogap Phase in $La_{1.8-x}Eu_{0.2}Sr_xCuO_4$

Anne Missiaen, Hadrien Mayaffre, Steffen Krämer, Dan Zhao, Yanbing Zhou, Tao Wu, Xianhui Chen, Sunseng Pyon, Tomohiro Takayama, Hidenori Takagi, David LeBoeuf, and Marc-Henri Julien

Phys. Rev. X **15**, 021010 (2025) - Published 10 April, 2025

Stripe order of spins and charges in cuprates is linked to the pseudogap, as both phenomena are confined below the same critical electronic density. This raises new questions about the strange metal phase found above this critical density.

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Synthetic High Angular Momentum Spin Dynamics in a Microwave Oscillator

Saswata Roy, Alen Senanian, Christopher S. Wang, Owen C. Wetherbee, Luojia Zhang, B. Cole, C. P. Larson, E. Yelton, Kartikeya Arora, Peter L. McMahon, B. L. T. Plourde, Baptiste Royer, and Valla Fatemi

Phys. Rev. X **15**, 021009 (2025) - Published 8 April, 2025

A new control scheme simplifies quantum harmonic oscillator manipulation, linking control parameters to quantum behavior. It enables spin-like behavior for novel quantum information processing.

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