

*The Table of Contents is a total listing of Parts A, B, and C.*  
*Part A consists of pages L040201–042459, Part B pages 042602–043128, and Part C pages 043301–049902(E).*

## PART A

### LETTERS

#### Fundamental concepts

- Disappearance of measurement-induced phase transition in a quantum spin system for large sizes (7 pages) . . . . . L040201  
Paranjoy Chaki, Protyush Nandi, Ujjwal Sen, and Subinay Dasgupta

#### Quantum information science

- Entanglement production in the decay of a metastable state (5 pages) . . . . . L040401  
Sergei Khlebnikov
- Optimal sample complexity for testing unitary properties (7 pages) . . . . . L040402  
Masahito Hayashi, Yu-Ao Chen, Chenghong Zhu, and Xin Wang
- Creating multicomponent Schrödinger cat states in a coupled qubit-oscillator system (6 pages) . . . . . L040403  
Pavel Stránský and Pavel Cejnar

#### Quantum technologies

- High-fidelity entanglement of metastable trapped-ion qubits with integrated erasure conversion (6 pages) . . . . . L040601  
A. Quinn, G. J. Gregory, I. D. Moore, S. Brudney, J. Metzner, E. R. Ritchie, J. O'Reilly,  
D. J. Wineland, and D. T. C. Allcock
- Boosted fusion gates above the percolation threshold for scalable graph-state generation (6 pages) . . . . . L040602  
Yong-Peng Guo, Geng-Yan Zou, Xing Ding, Qi-Hang Zhang, Mo-Chi Xu, Run-Ze Liu, Jun-Yi Zhao,  
Zhen-Xuan Ge, Li-Chao Peng, Ke-Mi Xu, Yi-Yang Lou, Zhen Ning, Lin-Jun Wang, Hui Wang,  
Yong-Heng Huo, Yu-Ming He, Chao-Yang Lu, and Jian-Wei Pan
- Chaos-mediated quantum state discrimination near unit fidelity (6 pages) . . . . . L040603  
Sourav Paul, Anant Vijay Varma, Yogesh N. Joglekar, and Sourin Das

#### Light-induced processes in atomic-scale systems

- Orbital orientation resolving real-time attosecond ionization and rescattering dynamics (6 pages) . . . . . L041101  
Lin Han, Jing-Jing Zhang, Hong-Gang Luo, and Peng-Cheng Li



(Continued)



2469-9926(202604)113:4:B;1-T

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                                                                                                                                                                                                                                                        |         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Coulomb crystallization of xenon highly charged ions in a laser-cooled $\text{Ca}^+$ matrix (7 pages) . . . . .                                                                                                                                                                                                                                                                        | L041102 |
| Leonid Prokhorov, Aaron A. Smith, Mingyao Xu, Kostas Georgiou, Vera Guarrera,<br>Lakshmi P. Kozhiparambil Sajith, Elwin A. Dijck, Christian Warnecke, Malte Wehrheim,<br>Alexander Wilzewski, Laura Blackburn, Matthias Keller, Vincent Boyer, Thomas Pfeifer, Ullrich Schwanke,<br>Cigdem Issever, Steven Worm, Piet O. Schmidt, José R. Crespo López-Urrutia, and Giovanni Barontini |         |
| <b>Ultracold systems and matter waves</b>                                                                                                                                                                                                                                                                                                                                              |         |
| Quantized transport of solitons in Bose-Einstein condensates driven by spin-orbit coupling (6 pages) . . . . .                                                                                                                                                                                                                                                                         | L041301 |
| Yaroslav V. Kartashov, Vladimir V. Konotop, and Dmitry A. Zezyulin                                                                                                                                                                                                                                                                                                                     |         |
| Coherent transport in two-dimensional disordered potentials under spatially uniform $\text{SU}(2)$ gauge fields (8 pages) . . . . .                                                                                                                                                                                                                                                    | L041302 |
| Masataka Kakoi, Christian Miniatura, and Keith Slevin                                                                                                                                                                                                                                                                                                                                  |         |
| Stability of dark solitons in a bubble Bose-Einstein condensate (6 pages) . . . . .                                                                                                                                                                                                                                                                                                    | L041303 |
| Raphael Wicthy Sallatti, Lauro Tomio, Dmitry E. Pelinovsky, and Arnaldo Gammal                                                                                                                                                                                                                                                                                                         |         |
| Index theorem and vortex kinetics in Bose-Einstein condensates on a Haldane sphere with a magnetic<br>monopole (6 pages) . . . . .                                                                                                                                                                                                                                                     | L041304 |
| Xi-Yu Chen, Lijia Jiang, Tao Yang, and Jun-Hui Zheng                                                                                                                                                                                                                                                                                                                                   |         |
| Signatures of rigidity and second sound in dipolar supersolids (8 pages) . . . . .                                                                                                                                                                                                                                                                                                     | L041305 |
| G. A. Bougas, T. Bland, H. R. Sadeghpour, and S. I. Mistakidis                                                                                                                                                                                                                                                                                                                         |         |
| Unified theory of attractive and repulsive polarons in a one-dimensional Bose gas (6 pages) . . . . .                                                                                                                                                                                                                                                                                  | L041306 |
| Nikolay Yegovtsev, T. Alper Yoğurt, Matthew T. Eiles, and Victor Gurarie                                                                                                                                                                                                                                                                                                               |         |
| Emergent universality class in dissipative quantum systems with dipole symmetry (7 pages) . . . . .                                                                                                                                                                                                                                                                                    | L041307 |
| Wenbo Zhou, Yuke Zhang, and Pengfei Zhang                                                                                                                                                                                                                                                                                                                                              |         |
| Universal relations in long-range quantum spin chains (7 pages) . . . . .                                                                                                                                                                                                                                                                                                              | L041308 |
| Ning Sun, Lei Feng, and Pengfei Zhang                                                                                                                                                                                                                                                                                                                                                  |         |
| <b>Photonics, nonlinear optics, and optomechanics</b>                                                                                                                                                                                                                                                                                                                                  |         |
| Autonomous phonon maser in levitated spin mechanics (7 pages) . . . . .                                                                                                                                                                                                                                                                                                                | L041501 |
| Mohamed Hatifi                                                                                                                                                                                                                                                                                                                                                                         |         |
| Observation of multiorbital Fano resonances in photonic lattices (6 pages) . . . . .                                                                                                                                                                                                                                                                                                   | L041502 |
| Diego Guzmán-Silva, Maritza Ahumada, Polette Parra-Palavecino, Alexis R. Legón,<br>Pedro A. Orellana, and Rodrigo A. Vicencio                                                                                                                                                                                                                                                          |         |
| Green's-function expansion for multiple coupled optical resonators with finite retardation using quasinormal<br>modes (6 pages) . . . . .                                                                                                                                                                                                                                              | L041503 |
| Robert Meiners Fuchs, Juanjuan Ren, Stephen Hughes, and Marten Richter                                                                                                                                                                                                                                                                                                                 |         |
| <b>Quantum optics</b>                                                                                                                                                                                                                                                                                                                                                                  |         |
| Nonclassicality of multiphoton-added cat states (7 pages) . . . . .                                                                                                                                                                                                                                                                                                                    | L041701 |
| Jhordan Santiago and Petr Steindl                                                                                                                                                                                                                                                                                                                                                      |         |
| Polarization entanglement in atomic biphotons via orbital-angular-momentum-to-spin mapping (6 pages) . . . . .                                                                                                                                                                                                                                                                         | L041702 |
| Chang-Wei Lin, Yi-Ting Ma, Jiun-Shiuan Shiu, and Yong-Fan Chen                                                                                                                                                                                                                                                                                                                         |         |

(Continued)

## ARTICLES

**Fundamental concepts**

|                                                                                                                                             |        |
|---------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Mereological quantum phase transitions ( <i>9 pages</i> ) . . . . .                                                                         | 042201 |
| Paolo Zanardi, Emanuel Dallas, and Faidon Andreadakis                                                                                       |        |
| Quantum phase transitions and frustration in a three-spin-boson model with independent baths ( <i>10 pages</i> ) . . . . .                  | 042202 |
| Shu He and Li-Wei Duan                                                                                                                      |        |
| Restoring a missing duality in quantum mechanics ( <i>10 pages</i> ) . . . . .                                                              | 042203 |
| Sheng Ran                                                                                                                                   |        |
| Quantum contextuality from measurement invasiveness ( <i>11 pages</i> ) . . . . .                                                           | 042204 |
| A. Navoni, M. G. Genoni, and A. Smirne                                                                                                      |        |
| Open quantum systems beyond equilibrium: Lindblad equation and path integral molecular dynamics ( <i>14 pages</i> ) . . . . .               | 042205 |
| Benedikt M. Reible, Somayeh Ahmadkhani, and Luigi Delle Site                                                                                |        |
| Counterfactual quantum measurements ( <i>13 pages</i> ) . . . . .                                                                           | 042206 |
| Ingita Banerjee, Kiarn T. Laverick, and Howard M. Wiseman                                                                                   |        |
| Quantum speed limit in open quantum systems: A stochastic approach ( <i>11 pages</i> ) . . . . .                                            | 042207 |
| Xue-Bing Wang and Wei Wu                                                                                                                    |        |
| Quantum telegraph behavior without photons ( <i>9 pages</i> ) . . . . .                                                                     | 042208 |
| Truong-Son P. Văn, Daniel Maienshein, and David W. Snoke                                                                                    |        |
| Geometric quantum thermodynamics: A fiber bundle approach ( <i>11 pages</i> ) . . . . .                                                     | 042209 |
| Tiago Pernambuco and Lucas C. Céleri                                                                                                        |        |
| Effect of the gradient of the spin polarization in density functional approximations ( <i>7 pages</i> ) . . . . .                           | 042210 |
| Rohan Maniar and John P. Perdew                                                                                                             |        |
| Robust self-testing and certified randomness based on an arbitrary-input Bell inequality ( <i>31 pages</i> ) . . . . .                      | 042211 |
| Rajdeep Paul, Sneha Munshi, and A. K. Pan                                                                                                   |        |
| Temporal nonclassicality in continuous-time quantum walks ( <i>15 pages</i> ) . . . . .                                                     | 042212 |
| Paolo Luppi, Claudia Benedetti, and Andrea Smirne                                                                                           |        |
| Topological enhancement of a $\mathcal{PT}$ -symmetric Su-Schrieffer-Heeger quantum battery ( <i>13 pages</i> ) . . . . .                   | 042213 |
| A-Long Zhou, Ya-Wen Xiao, Nuo Xu, Li-Li Gao, Long-Jie Li, Hang Zhou, Zi-Min Li, and Chuan-Cun Shu                                           |        |
| Tunneling in double-well potentials within Nelson's stochastic mechanics:<br>Application to ammonia inversion ( <i>16 pages</i> ) . . . . . | 042214 |
| Danilo F. Schafaschek, Giovani L. Vasconcelos, and Antônio M. S. Macêdo                                                                     |        |
| Contextual Heisenberg microscope ( <i>7 pages</i> ) . . . . .                                                                               | 042215 |
| Jan-Åke Larsson                                                                                                                             |        |
| Environment-assisted discrete time crystals in noninteracting quantum systems ( <i>8 pages</i> ) . . . . .                                  | 042216 |
| Gourab Das, Saptarshi Saha, and Rangeet Bhattacharyya                                                                                       |        |

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                            |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Anisotropy-induced dynamics in coupled quantum oscillators ( <i>13 pages</i> ) . . . . .                                                                   | 042217 |
| B. Vigneshwar, V. K. Chandrasekar, and D. V. Senthilkumar                                                                                                  |        |
| Quantum speed limits for open system dynamics based on a representation-basis-dependent $\ell_w^p$ -seminorm ( <i>13 pages</i> ) . . . . .                 | 042218 |
| H. F. Chau and Jinjie Li                                                                                                                                   |        |
| Reentrant topological phase transition in a periodically modulated Su-Schrieffer-Heeger model ( <i>8 pages</i> ) . . . . .                                 | 042219 |
| Xin-Yue Zhang, Xiao-Feng Nie, Jie Zhang, Li-Nan Zhong, Ji Cao, and Hong-Fu Wang                                                                            |        |
| Finite-measurement-duration limits on measurement-driven quantum engines ( <i>5 pages</i> ) . . . . .                                                      | 042220 |
| Juyeon Yi and Yong Woon Kim                                                                                                                                |        |
| Statistical mechanics from quantum envariance and exchange symmetry ( <i>14 pages</i> ) . . . . .                                                          | 042221 |
| Amul Ojha, Shubhit Sardana, and Arnab Ghosh                                                                                                                |        |
| Spectral analysis of the Koopman operator as a framework for recovering Hamiltonian parameters in open quantum systems ( <i>13 pages</i> ) . . . . .       | 042222 |
| Jorge E. Pérez-García, Carlos Colchero, and Julio C. Gutiérrez-Vega                                                                                        |        |
| Fundamental and second-subharmonic Autler-Townes splitting in classical systems ( <i>7 pages</i> ) . . . . .                                               | 042223 |
| Ahmed A. Barakat, Avishek Chowdhury, Anh Tuan Le, and Eva M. Weig                                                                                          |        |
| Radiation of breathing vortex electron packets in magnetic field ( <i>11 pages</i> ) . . . . .                                                             | 042224 |
| G. V. Zmaga, G. K. Sizykh, D. V. Grosman, Qi Meng, Liping Zou, Pengming Zhang, and D. V. Karlovets                                                         |        |
| Quantum filtering formulation of the Diósi-Penrose model ( <i>6 pages</i> ) . . . . .                                                                      | 042225 |
| John E. Gough and Dylon Rees                                                                                                                               |        |
| Quantum-foundational implications of information erasure upon measurement ( <i>12 pages</i> ) . . . . .                                                    | 042226 |
| Alberto Montina and Stefan Wolf                                                                                                                            |        |
| <b>Quantum information science</b>                                                                                                                         |        |
| Practical quantum reservoir computing in Rydberg atom arrays ( <i>9 pages</i> ) . . . . .                                                                  | 042401 |
| Dong-Sheng Liu, Qing-Xuan Jie, Chang-Ling Zou, Xi-Feng Ren, and Guang-Can Guo                                                                              |        |
| Quantum key distribution by quantum energy teleportation ( <i>12 pages</i> ) . . . . .                                                                     | 042402 |
| Shlomi Dolev, Kazuki Ikeda, and Yaron Oz                                                                                                                   |        |
| Noise-canceling quantum feedback: Non-Hermitian dynamics with applications to state preparation and magic state distillation ( <i>27 pages</i> ) . . . . . | 042403 |
| Tathagata Karmakar, Philippe Lewalle, Yipei Zhang, and K. Birgitta Whaley                                                                                  |        |
| Search for high-threshold qutrit magic-state distillation routines ( <i>15 pages</i> ) . . . . .                                                           | 042404 |
| Shiroman Prakash and Rishabh Singhal                                                                                                                       |        |
| Sublogarithmic distillation in all prime dimensions using punctured Reed-Muller codes ( <i>16 pages</i> ) . . . . .                                        | 042405 |
| Tanay Saha and Shiroman Prakash                                                                                                                            |        |
| Quantum limits of exoplanet detection and localization ( <i>23 pages</i> ) . . . . .                                                                       | 042406 |
| Nico Deshler, Sebastiaan Haffert, and Amit Ashok                                                                                                           |        |

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                           |        |
|-------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Constrained free energy minimization for the design of thermal states and stabilizer thermodynamic systems (32 pages) . . . . .           | 042407 |
| Michele Minervini, Madison Chin, Jacob Kupperman, Nana Liu, Ivy Luo, Meghan Ly, Soorya Rethinasamy, Kathie Wang, and Mark M. Wilde        |        |
| Supervised learning of optimal pulse design for the adiabatic speedup under time-dependent noise (9 pages) . . . . .                      | 042408 |
| Jian-Long Gao, Nai-Jun Cui, Hong-Yang Ma, and Zhao-Ming Wang                                                                              |        |
| Engineering precise and robust effective Hamiltonians (32 pages) . . . . .                                                                | 042409 |
| Jiahui Chen and David Cory                                                                                                                |        |
| Physics and computation: An insight from non-Hermitian quantum computing (15 pages) . . . . .                                             | 042410 |
| Qi Zhang (张起) and Biao Wu (吴飙)                                                                                                            |        |
| Sensing decoherence by using edge states (5 pages) . . . . .                                                                              | 042411 |
| Andrey R. Kolovsky                                                                                                                        |        |
| Dense packing of the surface code: Code deformation procedures and hook-error-avoiding gate scheduling (14 pages) . . . . .               | 042412 |
| Kohei Fujiu, Shota Nagayama, Shin Nishio, Hideaki Kawaguchi, and Takahiko Satoh                                                           |        |
| Dynamical discontinuities in repeated weak measurements revealed by complex weak values (10 pages) . . . . .                              | 042413 |
| Lorena Ballesteros Ferraz                                                                                                                 |        |
| Mitigating detuning-induced systematic errors in entanglement-enhanced metrology (11 pages) . . . . .                                     | 042414 |
| Shingo Kukita and Yuichiro Matsuzaki                                                                                                      |        |
| Nonlocality-assisted enhancement of error-free communication in noisy classical channels (18 pages) . . . . .                             | 042415 |
| Kunika Agarwal, Sahil Gopalkrishna Naik, Ananya Chakraborty, Samrat Sen, Pratik Ghosal, Biswajit Paul, Manik Banik, and Ram Krishna Patra |        |
| Decoding three-dimensional color codes with boundaries (13 pages) . . . . .                                                               | 042416 |
| Friederike Butt, Lars Esser, and Markus Müller                                                                                            |        |
| Imprecise quantum steering inequalities in tripartite systems (9 pages) . . . . .                                                         | 042417 |
| Yan Zhao, Li-Juan Li, Zheng-Peng Xu, Liu Ye, and Dong Wang                                                                                |        |
| Semi-device-independent randomness certification on discretized continuous-variable platforms (17 pages) . . . . .                        | 042418 |
| Moisés Alves, Vitor L. Sena, Santiago Zamora, Tailan S. Sarubi, A. de Oliveira Junior, Alexandre B. Tacla, and Rafael Chaves              |        |
| Quantum speed limits based on Jensen-Shannon and Jeffreys divergences for general physical processes (23 pages) . . . . .                 | 042419 |
| Jucelino Ferreira de Sousa and Diego Paiva Pires                                                                                          |        |
| Phase estimation with compressed controlled time evolution (14 pages) . . . . .                                                           | 042420 |
| Erenay Karacan                                                                                                                            |        |
| Measurement-based quantum machine learning (14 pages) . . . . .                                                                           | 042421 |
| Luis Mantilla Calderón, Robert Raussendorf, Polina Feldmann, and Dmytro Bondarenko                                                        |        |
| Several kinds of Gaussian quantum channels related to Einstein-Podolsky-Rosen steering (11 pages) . . . . .                               | 042422 |
| Ruifen Ma, Yanjing Sun, and Xiaofei Qi                                                                                                    |        |

(Continued)

# CONTENTS - *Continued*

| PHYSICAL REVIEW A                                                                                                | THIRD SERIES, VOLUME 113, NUMBER 4 | APRIL 2026 |
|------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|
| Randomization accelerating series-truncated quantum algorithms (22 pages) . . . . .                              |                                    | 042423     |
| Yue Wang and Qi Zhao                                                                                             |                                    |            |
| Efficient optical configurations for trapped-ion entangling gates (21 pages) . . . . .                           |                                    | 042424     |
| Aditya Milind Kolhatkar and Karan K. Mehta                                                                       |                                    |            |
| Detecting quantum many-body states with imperfect measuring devices (19 pages) . . . . .                         |                                    | 042425     |
| Kenan Uriostegui, Chrysomalis Chrysomalakos, Valentina Rascón Barajas,<br>Igor Vázquez Mota, and Carlos Pineda   |                                    |            |
| Systematic approach to hyperbolic quantum error correction codes (14 pages) . . . . .                            |                                    | 042426     |
| Ahmed Adel Mahmoud, Kamal Mohamed Ali, and Steven Rayan                                                          |                                    |            |
| Noise-cancellation-induced surge of quantum entanglement (13 pages) . . . . .                                    |                                    | 042427     |
| Nan Wang, Shi-Yan Li, Wei-Yue Zhang, Xiao-Fei Ou, Ai-Dong Zhu, and Lin Yu                                        |                                    |            |
| Butterfly effect in encoding-decoding quantum circuits (12 pages) . . . . .                                      |                                    | 042428     |
| Emanuel Dallas, Faidon Andreadakis, and Paolo Zanardi                                                            |                                    |            |
| Nonlocal nonstabilizerness generation and information scrambling in noisy Clifford circuits (11 pages) . . . . . |                                    | 042429     |
| Emanuel Dallas and Paolo Zanardi                                                                                 |                                    |            |
| Preparation circuits for matrix product states by classical variational disentanglement (15 pages) . . . . .     |                                    | 042430     |
| Refik Mansuroglu and Norbert Schuch                                                                              |                                    |            |
| Symmetry-based quantum codes beyond the Pauli group (21 pages) . . . . .                                         |                                    | 042431     |
| Zachary P. Bradshaw, Margarite L. LaBorde, and Dillon Montero                                                    |                                    |            |
| Stabilized entanglement between floating-electron-based qubits (11 pages) . . . . .                              |                                    | 042432     |
| Ji-kun Xie, Rong-teng Cao, Ya-long Ren, Sheng-li Ma, Ren Zhang, and Fu-li Li                                     |                                    |            |
| Decoherence to quantum theory from a causally indefinite post-quantum theory (11 pages) . . . . .                |                                    | 042433     |
| James Hefford and Matt Wilson                                                                                    |                                    |            |
| Optimal ququint diagonal gates for generating Wigner negativity (10 pages) . . . . .                             |                                    | 042434     |
| Lingxuan Feng and Shunlong Luo                                                                                   |                                    |            |
| Exact gradient for general cost functions in variational quantum algorithms (10 pages) . . . . .                 |                                    | 042435     |
| Jesus Urbaneja and Le Bin Ho                                                                                     |                                    |            |
| Fate of entanglement in quadratic Markovian dissipative systems (17 pages) . . . . .                             |                                    | 042436     |
| Fabio Caceffo and Vincenzo Alba                                                                                  |                                    |            |
| Thermal noise-immunized quantum state transfer through a microwave waveguide (18 pages) . . . . .                |                                    | 042437     |
| Da-Wei Wang, Chengsong Zhao, Hao-Ai, Weijun Cheng, and Yu-xi Liu                                                 |                                    |            |
| Using magic resource to realize probabilistic channel simulation (11 pages) . . . . .                            |                                    | 042438     |
| Yiran Wang and Yongming Li                                                                                       |                                    |            |
| Fault-tolerant encoding of logical qudits in spin systems (12 pages) . . . . .                                   |                                    | 042439     |
| Sumin Lim                                                                                                        |                                    |            |
| Bound entanglement in symmetric random induced states (9 pages) . . . . .                                        |                                    | 042440     |
| J. Louvet, F. Damanet, and T. Bastin                                                                             |                                    |            |

(Continued)

# CONTENTS - *Continued*

| PHYSICAL REVIEW A                                                                                                                              | THIRD SERIES, VOLUME 113, NUMBER 4 | APRIL 2026 |
|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|
| Erasing, converting, and communicating: The power of resource-nongenerating operations ( <i>14 pages</i> ) . . . . .                           |                                    | 042441     |
| Xian Shi                                                                                                                                       |                                    |            |
| Enhanced quantum battery capacity from quantum correlations ( <i>8 pages</i> ) . . . . .                                                       |                                    | 042442     |
| Fang-Yuan Zheng and Li-Hang Ren                                                                                                                |                                    |            |
| Harnessing quantum dynamics for robust and scalable quantum extreme learning machines ( <i>13 pages</i> ) . . . . .                            |                                    | 042443     |
| Payal D. Solanki and Anh Pham                                                                                                                  |                                    |            |
| Stochastic unravelings for Heisenberg picture and trace-nonpreserving dynamics ( <i>11 pages</i> ) . . . . .                                   |                                    | 042444     |
| Federico Settimo, Kimmo Luoma, Dariusz Chruściński, Bassano Vacchini, Andrea Smirne, and Jyrki Piilo                                           |                                    |            |
| Epistemic incompleteness of quantum theory ( <i>28 pages</i> ) . . . . .                                                                       |                                    | 042445     |
| Anubhav Chaturvedi, Marcin Pawłowski, and Debashis Saha                                                                                        |                                    |            |
| Classical-quantum hybrid architecture for physics-informed neural networks ( <i>20 pages</i> ) . . . . .                                       |                                    | 042446     |
| Said Lantigua, Gilson Giraldi, and Renato Portugal                                                                                             |                                    |            |
| Qubit-oscillator-based gate implementations for approximate Gottesman-Kitaev-Preskill codes ( <i>24 pages</i> ) . . . . .                      |                                    | 042447     |
| Lukas Brenner, Beatriz Dias, and Robert Koenig                                                                                                 |                                    |            |
| Geometric entanglement entropy on projective Hilbert space ( <i>13 pages</i> ) . . . . .                                                       |                                    | 042448     |
| Loris Di Cairano                                                                                                                               |                                    |            |
| Optimal quantum precision in noise estimation: Necessity of entanglement ( <i>19 pages</i> ) . . . . .                                         |                                    | 042449     |
| Shuva Mondal, Priya Ghosh, and Ujjwal Sen                                                                                                      |                                    |            |
| Quantum speed limit for observables from quantum asymmetry ( <i>8 pages</i> ) . . . . .                                                        |                                    | 042450     |
| Agung Budiyo, Michael Moody, Hadyan L. Prihadi, Rafika Rahmawati, and Sebastian Deffner                                                        |                                    |            |
| Locating Rydberg decay error in the SWAP leakage reduction circuit protocol ( <i>13 pages</i> ) . . . . .                                      |                                    | 042451     |
| Cheng-Cheng Yu, Yu-Hao Deng, Chao-Yang Lu, Ming-Cheng Chen, and Jian-Wei Pan                                                                   |                                    |            |
| Universal quantum control over non-Hermitian continuous-variable systems ( <i>14 pages</i> ) . . . . .                                         |                                    | 042452     |
| Zhu-yao Jin and Jun Jing                                                                                                                       |                                    |            |
| From Bell products to Greenberger-Horne-Zeilinger states: Quantum memories via emergent Hamiltonians ( <i>15 pages</i> ) . . . . .             |                                    | 042453     |
| Anubhab Sur, Qiujiang Guo, and Rubem Mondaini                                                                                                  |                                    |            |
| Chip-based measurement-device-independent quantum key distribution in the presence of polarization-dependent loss ( <i>8 pages</i> ) . . . . . |                                    | 042454     |
| Jiali Zhu, Huajian Ding, Xingyu Zhou, Chunxue Zhang, Chunhui Zhang, Jian Li, Junming An, and Qin Wang                                          |                                    |            |
| Efficient quantum state tomography with Chebyshev polynomials ( <i>13 pages</i> ) . . . . .                                                    |                                    | 042455     |
| Hao Su, Shiyong Xiong, and Yue Yang                                                                                                            |                                    |            |
| Bayesian rational agents in iterated quantum games ( <i>17 pages</i> ) . . . . .                                                               |                                    | 042456     |
| John B. DeBroya and Peter J. Love                                                                                                              |                                    |            |
| Quantum channel masking ( <i>8 pages</i> ) . . . . .                                                                                           |                                    | 042457     |
| Anna Honeycutt, Hailey Murray, and Eric Chitambar                                                                                              |                                    |            |

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

Certification of genuine multipartite high-dimensional quantum teleportation (*17 pages*) . . . . . 042458  
Neng-Fei Gong, Feng-Xiao Sun, and Tie-Jun Wang

Constraint-optimal driven allocation for scalable quantum error correction decoder scheduling (*17 pages*) . . . . . 042459  
Dongmin Kim, Jeonggeun Seo, Youngsun Han, and Yongtae Kim

## PART B

### Quantum technologies

Operator-aware shadow importance sampling for accurate fidelity estimation (*10 pages*) . . . . . 042602  
Hyunho Cha, Sangwoo Hong, and Jungwoo Lee

Benchmarking single-qubit gates on a neutral-atom quantum processor (*10 pages*) . . . . . 042603  
A. Rozanov, B. Bantysh, I. Bobrov, G. Struchalin, and S. Straupe

Creating qubit states with degenerate two-level systems (*15 pages*) . . . . . 042604  
Zhuoran Bao and Daniel F. V. James

Ramanujan-modulated multitone control for high-fidelity quantum state preparation (*9 pages*) . . . . . 042605  
Eram Taslima and Shyam Kamal

Measuring multiparticle indistinguishability with the generalized bunching probability (*27 pages*) . . . . . 042606  
Shawn Geller and Emanuel Knill

Gottesman-Knill limit on one-way communication complexity: Tracing the quantum advantage down to magic resources (*11 pages*) . . . . . 042607  
Snehasish Roy Chowdhury, Sahil Gopalkrishna Naik, Ananya Chakraborty, Ram Krishna Patra, Subhendu B. Ghosh, Pratik Ghosal, Manik Banik, and Ananda G. Maity

Automated discovery of heralded ballistic graph state generators for fusion-based photonic quantum computation (*22 pages*) . . . . . 042608  
Gavin S. Hartnett, Dave Kielpinski, Smarak Maity, Pranav S. Mundada, Yuval Baum, and Michael R. Hush

Noise-resilient universal quantum computing in the presence of anisotropic noise (*6 pages*) . . . . . 042609  
Yang-Yang Xie, Zhao-Ming Wang, and Lian-Ao Wu

Hierarchical quantum approximation optimization algorithm for solving graph-coloring problems (*18 pages*) . . . . 042610  
Dongmei Liu, Jian Li, Xiubo Chen, Shibin Zhang, Yan Chang, and Lili Yan

Efficient variational quantum Korkin-Zolotarev algorithm for solving shortest-vector problems (*14 pages*) . . . . . 042611  
Xiaokai Hou, Guoqing Zhou, Shan Jin, Yang Li, Wei Huang, Ao Sun, Xiaoting Wang, and Bingjie Xu

Decay of a transmon qubit in a broadband one-dimensional cavity (*12 pages*) . . . . . 042612  
Ya. S. Greenberg, A. A. Shtygashev, and O. V. Kibis

Line search by quantum logic spectroscopy enhanced with squeezing and statistical tests (*9 pages*) . . . . . 042613  
Ivan Vybornyi, Shuying Chen, Lukas J. Spieß, Piet O. Schmidt, and Klemens Hammerer

Symmetric controlled-Z gate for ultracold neutral atoms based on counterdiabatic driving at Rydberg excitation (*13 pages*) . . . . . 042614  
I. I. Beterov, K. V. Kozenko, I. I. Ryabtsev, and Peng Xu

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                           |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Tilt-induced localization in interacting Bose-Einstein condensates for quantum sensing ( <i>9 pages</i> ) . . . . .                                       | 042615 |
| Argha Debnath, Mariusz Gajda, and Debraj Rakshit                                                                                                          |        |
| Multilevel quantum batteries: Large battery capacity and high charging speed ( <i>7 pages</i> ) . . . . .                                                 | 042616 |
| Zefeng Huang, Dayang Zhang, Zhuoheng Wang, Yu Zhao, Youbin Yu, Guangri Jin, and Aixi Chen                                                                 |        |
| Shallow instantaneous quantum polynomial-time circuits for generative modeling on noisy intermediate-scale quantum hardware ( <i>15 pages</i> ) . . . . . | 042617 |
| Oriol Balló-Gimbernat, Marcos Arroyo-Sánchez, Paula García-Molina, Adan Garriga, and Fernando Vilarino                                                    |        |
| Existence of a robust optimal control process for efficient measurements in a two-qubit system ( <i>8 pages</i> ) . . . . .                               | 042618 |
| Ricardo Rodriguez, Nam Nguyen, Elizabeth Behrman, Andy C. Y. Li, and James Steck                                                                          |        |
| High-fidelity rapid entanglement gate based on dynamical symmetry-induced transparency ( <i>11 pages</i> ) . . . . .                                      | 042619 |
| Shu-Ying Mu, Xie-Qian Li, Wei Wu, Chun-Wang Wu, Yi Xie, and Ping-Xing Chen                                                                                |        |
| Quantum sensing via large spin clusters in solid-state NMR: Optimal coherence order for practical sensing ( <i>9 pages</i> ) . . . . .                    | 042620 |
| C. Alexander and T. S. Mahesh                                                                                                                             |        |
| Use of faulty states in cat-code error correction ( <i>16 pages</i> ) . . . . .                                                                           | 042621 |
| Michael Hanks, Soovin Lee, Nicolo Lo Piparo, Shin Nishio, William J. Munro, Kae Nemoto, and M. S. Kim                                                     |        |
| Robust universal braiding with nonsemisimple Ising anyons ( <i>23 pages</i> ) . . . . .                                                                   | 042622 |
| Filippo Iulianelli, Sung Kim, Joshua Sussan, and Aaron D. Lauda                                                                                           |        |
| Leakage suppression in quantum control via static parameter offsets ( <i>15 pages</i> ) . . . . .                                                         | 042623 |
| Ting Lin, Zi-Hao Qin, Zheng-Yuan Xue, and Tao Chen                                                                                                        |        |
| Nonlocal and quantum advantages in network coding for multiple access channels ( <i>11 pages</i> ) . . . . .                                              | 042624 |
| Jiyoung Yun, Seung-Hyun Nam, Hyun-Young Park, Ashutosh Rai, Si-Hyeon Lee, and Joonwoo Bae                                                                 |        |
| Penalty-free quantum algorithm to find energy eigenstates ( <i>13 pages</i> ) . . . . .                                                                   | 042625 |
| Nannan Ma, Heng Dai, and Jiangbin Gong                                                                                                                    |        |
| Multiensemble superradiance for distributed quantum sensing ( <i>20 pages</i> ) . . . . .                                                                 | 042626 |
| Kang Shen, Xiangming Hu, and Fei Wang                                                                                                                     |        |
| Quantum gates via dynamical decoupling of a central qubit on IBMQ and $^{15}\text{N}$ -vacancy centers in diamond ( <i>17 pages</i> ) . . . . .           | 042627 |
| Lucas Tsunaki, Michael Dotan, Kseniia Volkova, and Boris Naydenov                                                                                         |        |
| Parallel distributed quantum gates for dual-species quantum emitters ( <i>14 pages</i> ) . . . . .                                                        | 042628 |
| Zhihao Xie, Adam Miranowicz, Zhenhua Li, Tao Li, and Franco Nori                                                                                          |        |
| <b>Atomic and molecular structure and dynamics; high-precision experiments; chemical physics</b>                                                          |        |
| Global isotopic analysis of hyperfine-resolved rotational spectroscopic data for barium monofluoride, BaF ( <i>12 pages</i> ) . . . . .                   | 042801 |
| Alex Preston, Graceson Aufderheide, Will Ballard, Richard Mawhorter, and Jens-Uwe Grabow                                                                  |        |
| Relativistic exact two-component theory in the generalized pseudospectral representation ( <i>10 pages</i> ) . . . . .                                    | 042802 |
| Xubo Wang, Phay J. Ho, Chaoqun Zhang, and Lan Cheng                                                                                                       |        |

(Continued)

# CONTENTS - *Continued*

| PHYSICAL REVIEW A                                                                                                                                                                                                                                                                                                                                        | THIRD SERIES, VOLUME 113, NUMBER 4 | APRIL 2026 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|
| Nuclear mass effects on low-energy resonant features in He + H <sub>2</sub> scattering (10 pages) . . . . .                                                                                                                                                                                                                                              |                                    | 042803     |
| Jacqueline Stordock, Bikramaditya Mandal, and Naduvalath Balakrishnan                                                                                                                                                                                                                                                                                    |                                    |            |
| Energy spectra of electron-positron pairs produced in bound-bound muon transitions (8 pages) . . . . .                                                                                                                                                                                                                                                   |                                    | 042804     |
| Oleg Yu. Andreev, Deyang Yu, Konstantin N. Lyashchenko, and Daria M. Vasileva                                                                                                                                                                                                                                                                            |                                    |            |
| <i>Ab initio</i> study of highly-charged-ion-induced Coulomb-explosion imaging (12 pages) . . . . .                                                                                                                                                                                                                                                      |                                    | 042805     |
| Misa Viveiros, Samuel S. Taylor, Cody Covington, and Kálmán Varga                                                                                                                                                                                                                                                                                        |                                    |            |
| Molecular effects in low-energy muon transfer from muonic hydrogen to oxygen (10 pages) . . . . .                                                                                                                                                                                                                                                        |                                    | 042806     |
| I. Boradjiev, A. Adamczak, D. Bakalov, M. Baruzzo, R. Benocci, M. Bonesini, S. Capra, E. Christova, M. Clemenza, M. Danailov, P. Danev, E. Fasci, L. Gianfrani, A. D. Hillier, K. Ishida, A. Menegolli, E. Mocchiutti, S. Monzani, L. Moretti, C. Pizzolotto, R. Rossini, A. Sbrizzi, M. Stoilov, H. S. Tonchev, A. Vacchi, E. Vallazza, and K. Yokoyama |                                    |            |
| Formation of HDO, OH <sup>-</sup> , and OD <sup>-</sup> in low-energy O <sup>-</sup> + HD collisions (16 pages) . . . . .                                                                                                                                                                                                                                |                                    | 042807     |
| Jiří Táborský, Martin Čížek, Karel Houfek, Štěpán Roučka, Daniel Rednyk, Octavio Emmanuel Hernández Alvarez, Thuy Dung Tran, Artem Kovalenko, Petr Dohnal, Radek Plašil, and Juraj Glosík                                                                                                                                                                |                                    |            |
| Necessary and sufficient conditions for the <i>N</i> -representability of functionals of the one-electron reduced density matrix (5 pages) . . . . .                                                                                                                                                                                                     |                                    | 042808     |
| Jannis Erhard and Paul W. Ayers                                                                                                                                                                                                                                                                                                                          |                                    |            |
| Applicability of the Dirac-Fock method combined with core polarization in calculations of alkali-metal atoms (10 pages) . . . . .                                                                                                                                                                                                                        |                                    | 042809     |
| A. A. Bobylev, J. J. Lopez-Rodriguez, P. A. Kvasov, M. A. Reiter, D. A. Solov'yev, and T. A. Zalialutdinov                                                                                                                                                                                                                                               |                                    |            |
| Screened thin-target bremsstrahlung with partially ionized high- <i>Z</i> species (15 pages) . . . . .                                                                                                                                                                                                                                                   |                                    | 042810     |
| S. Guinchard, Y. Savoye-Peysson, and J. Decker                                                                                                                                                                                                                                                                                                           |                                    |            |
| Relativistic effects on positron binding to the triplet state of helium (12 pages) . . . . .                                                                                                                                                                                                                                                             |                                    | 042811     |
| D.-X. Zhao, K. Hu, M.-S. Wu, J.-Y. Zhang, K.-D. Wang, and Z.-C. Yan                                                                                                                                                                                                                                                                                      |                                    |            |
| Measurement of lifetime, hyperfine splitting, and Landé <i>g<sub>J</sub></i> factor of the <sup>2</sup> F <sub>5/2</sub> state in <sup>171</sup> Yb <sup>+</sup> (7 pages) . . . . .                                                                                                                                                                     |                                    | 042812     |
| Pavel Sidorov, Pavel A. Kamenskikh, Ilya S. Gerasin, Aleksandr S. Borisenko, Ilia V. Zalivako, Ilya A. Semerikov, Ksenia Yu. Khabarova, and Nikolay N. Kolachevsky                                                                                                                                                                                       |                                    |            |
| Relativistic nuclear recoil effects in hyperfine splitting of hydrogenic systems (13 pages) . . . . .                                                                                                                                                                                                                                                    |                                    | 042813     |
| Jakub Hevler, Andrzej Maroń, and Krzysztof Pachucki                                                                                                                                                                                                                                                                                                      |                                    |            |
| Close-coupling approach to electron scattering with multielectron targets (17 pages) . . . . .                                                                                                                                                                                                                                                           |                                    | 042814     |
| Thomas A. Gomez, Dmitry V. Fursa, Igor Bray, Mark C. Zammit, Christopher J. Fontes, and Jackson White                                                                                                                                                                                                                                                    |                                    |            |
| Anisotropy and polarization of prominent 4 <i>f</i> → 3 <i>d</i> characteristic lines of Ni-like to Ga-like gold ions excited by electron impact (8 pages) . . . . .                                                                                                                                                                                     |                                    | 042815     |
| J. Q. Wang, Y. Li, and Z. W. Wu                                                                                                                                                                                                                                                                                                                          |                                    |            |
| Rotational state changes in collisions of diatomic molecular ions with atomic ions (16 pages) . . . . .                                                                                                                                                                                                                                                  |                                    | 042816     |
| J. Martin Berglund, Michael Drewsen, and Christiane P. Koch                                                                                                                                                                                                                                                                                              |                                    |            |
| Rotational excitation in sympathetic cooling of diatomic molecular ions by laser-cooled atomic ions (10 pages) . . . . .                                                                                                                                                                                                                                 |                                    | 042817     |
| J. Martin Berglund, Michael Drewsen, and Christiane P. Koch                                                                                                                                                                                                                                                                                              |                                    |            |

(Continued)

# CONTENTS - Continued

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                                                                                                                                                                       |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| X-ray spectroscopy of $4f-3d$ transitions in Cr-like tungsten (9 pages) . . . . .                                                                                                                                                                                                                     | 042818 |
| Shihan Huang, Jifei Wu, Zhiming Tang, Ziqiang Tian, Shaokun Ma, Jinyu Li, Yang Yang,<br>Huajian Ji, Zichao Lin, Bo Lyu, Hongming Zhang, Xiaobin Ding, Ke Yao, and Yaming Zou                                                                                                                          |        |
| Initial-state control in mutual neutralization of $\text{Si}^-$ with $\text{Na}^+$ or $\text{K}^+$ revealing strong violations of Wigner's<br>spin-conservation rule (9 pages) . . . . .                                                                                                              | 042819 |
| Rachel Poulou, Åsa Larson, Paul Martini, MingChao Ji, Ansgar Simonsson, Stéfan Rosen,<br>Mikael Björkhage, Peter Reinhed, Mikael Blom, Jose Eduardo Navarro Navarrete,<br>Sadiq Muhammad, Julia Karls, Arnaud Dochain, Henning Zettergren,<br>Henrik Cederquist, Dag Hanstorp, and Henning T. Schmidt |        |
| High-sensitivity molecular spectroscopy of SrOH using magneto-optical trapping (13 pages) . . . . .                                                                                                                                                                                                   | 042820 |
| Annika Lunstad, Hiromitsu Sawaoka, Zack Lasner, Abdullah Nasir, Mingda Li,<br>Jack Mango, Rachel Fields, and John M. Doyle                                                                                                                                                                            |        |
| Subensemble correlations as a covariance geometry (19 pages) . . . . .                                                                                                                                                                                                                                | 042821 |
| Zuoxian Wang, Yuhao Zhang, Gaopu Hou, Zihua Liang, Gen Hu, Lu Liu,<br>Yuan Sun, Feilong Xu, and Mao Ye                                                                                                                                                                                                |        |
| Precision measurement of the ground-state hyperfine constant for $^9\text{Be}^+$ in a linear Paul trap via magnetically<br>insensitive hyperfine transitions (7 pages) . . . . .                                                                                                                      | 042822 |
| Zhi-yuan Ao, Wen-li Bai, Qian-yu Zhang, Wen-cui Peng, and Xin Tong                                                                                                                                                                                                                                    |        |
| QED vacuum polarization in the Coulomb field of a nucleus: A method of high-order calculation (17 pages) . . . . .                                                                                                                                                                                    | 042823 |
| Sergey Volkov                                                                                                                                                                                                                                                                                         |        |
| Hyperfine structures of $4s$ , $5s$ , $^2S_{1/2}$ , $3p$ $^2P_{1/2,3/2}$ , and mixed $nd$ $y^2D_{3/2,5/2}$ states in $^{27}\text{Al}$ I (13 pages) . . . . .                                                                                                                                          | 042824 |
| B. J. Rickey, A. Brinson, A. Chakraborty, A. Dockery, R. F. Garcia Ruiz, J. Kartheim, K. Minamisono,<br>A. Ortiz-Cortes, B. K. Sahoo, L. V. Skripnikov, A. R. Vernon, and S. G. Wilkins                                                                                                               |        |
| Nuclear spin conversion induced by spin-torsion interaction in internal-rotor molecules (8 pages) . . . . .                                                                                                                                                                                           | 042825 |
| Li-Sha Ma                                                                                                                                                                                                                                                                                             |        |
| Enantioselective three-dimensional orientation of chiral molecules with a linearly polarized fundamental pulse<br>and an elliptically polarized second-harmonic pulse (13 pages) . . . . .                                                                                                            | 042826 |
| Md. Maruf Hossain and Hirofumi Sakai                                                                                                                                                                                                                                                                  |        |
| Three-body fragmentation dynamics of the propene trication produced by 1-MeV/u $\text{C}^{4+}$ impact (11 pages) . . . . .                                                                                                                                                                            | 042827 |
| Zhencen He, Mingliang Duan, Zhuohang He, Shuyu Zhang, and Zhimin Hu                                                                                                                                                                                                                                   |        |
| <b>Light-induced processes in atomic-scale systems</b>                                                                                                                                                                                                                                                |        |
| Spin-exchange collisions in optical pumping of $^{129}\text{Xe}$ : A multiscale simulation (17 pages) . . . . .                                                                                                                                                                                       | 043101 |
| Perttu Hilla, Marko Tuomela, Jyrki Rantaharju, and Juha Vaara                                                                                                                                                                                                                                         |        |
| Trapping of electrons and $^{40}\text{Ca}^+$ ions in a dual-frequency Paul trap (11 pages) . . . . .                                                                                                                                                                                                  | 043102 |
| Vladimir Mikhailovskii, Natalija Sheth, Guofeng Qu, Michal Hejduk, Niklas Vilhelm Lausti, K. T. Satyajith,<br>Christian Smorra, Günther Werth, Neha Yadav, Qian Yu, Clemens Matthiesen, Hartmut Häffner,<br>Ferdinand Schmidt-Kaler, Hendrik Bekker, and Dmitry Budker                                |        |
| Rainbow retrieval of atomic time delays in attosecond streaking (8 pages) . . . . .                                                                                                                                                                                                                   | 043103 |
| Anatoli Kheifets, Vladislav Serov, Federico Vismarra, and Hans Jakob Wörner                                                                                                                                                                                                                           |        |

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                                                                                                                                                                                                                             |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Bistability of optical properties of cesium vapor due to collective interaction of alignment and orientation under strong spin-exchange conditions ( <i>10 pages</i> ) . . . . .                                                                                                                                                                            | 043104 |
| M. V. Petrenko and A. K. Vershovskii                                                                                                                                                                                                                                                                                                                        |        |
| Influence of the rf drive frequency on ion-atom collisions in a hybrid trap ( <i>9 pages</i> ) . . . . .                                                                                                                                                                                                                                                    | 043105 |
| Fei Wang, Wei-Chen Liang, Wei-Bo Yin, Jing-Yu Qian, Feng-Dong Jia, Ping Xue, and Zhi-Ping Zhong                                                                                                                                                                                                                                                             |        |
| High-harmonic generation from two weakly coupled molecules: A simple tight-binding model ( <i>9 pages</i> ) . . . . .                                                                                                                                                                                                                                       | 043106 |
| Lina Bielke, Samuel Schöpa, Falk-Erik Wiechmann, Franziska Fennel, and Dieter Bauer                                                                                                                                                                                                                                                                         |        |
| Strong-field ionization of N <sub>2</sub> in two-color circularly polarized laser fields ( <i>10 pages</i> ) . . . . .                                                                                                                                                                                                                                      | 043107 |
| Zhuoyan Zhou, Xiaoxiao Long, Peizeng Li, Yankun Dou, Yang Wang, Yu Liu, Jingying Xiao, Hongze Duan, and Chengyin Wu                                                                                                                                                                                                                                         |        |
| Ultrafast optically induced tunneling in narrow metallic gaps from the time-dependent density-functional perspective ( <i>26 pages</i> ) . . . . .                                                                                                                                                                                                          | 043108 |
| Boyang Ma, Antton Babaze, Michael Krüger, Javier Aizpurua, and Andrei G. Borisov                                                                                                                                                                                                                                                                            |        |
| Revealing signals of higher-order nonlinear showers in particle-laser collisions ( <i>11 pages</i> ) . . . . .                                                                                                                                                                                                                                              | 043109 |
| T. G. Blackburn, B. King, and M. Samuelsson                                                                                                                                                                                                                                                                                                                 |        |
| Dichroic electron emission patterns from oriented helium ions ( <i>6 pages</i> ) . . . . .                                                                                                                                                                                                                                                                  | 043110 |
| Niclas Wieland, Klaus Bartschat, Filippa Dudda, René Wagner, Philipp Schmidt, Carlo Callegari, Alexander Demidovich, Giovanni De Ninno, Michele Di Fraia, Jiri Hofbrucker, Michele Manfreda, Valerija Music, Oksana Plekan, Kevin C. Prince, Daniel E. Rivas, Marco Zangrando, Nicolas Douguet, Alexei N. Grum-Grzhimailo, Michael Meyer, and Markus Ilchen |        |
| Ultrafast x-ray imaging of coherently controlled molecular dynamics in real space and time ( <i>8 pages</i> ) . . . . .                                                                                                                                                                                                                                     | 043111 |
| Thomas R. Hopper, James M. Glowina, and Adi Natan                                                                                                                                                                                                                                                                                                           |        |
| Role of $3p \rightarrow 3d$ core-to-core resonance in the enhanced multiphoton ionization kinetics of Kr driven by x-ray free-electron laser ( <i>10 pages</i> ) . . . . .                                                                                                                                                                                  | 043112 |
| Jie Yan, Li Huang, Yongjun Li, Yong Hou, Fengtao Jin, Chongyang Chen, Cheng Gao, Jiaolong Zeng, and Jianmin Yuan                                                                                                                                                                                                                                            |        |
| Nonadiabaticity-induced abnormal Coulomb-focusing effect in an orthogonally polarized two-color laser field ( <i>12 pages</i> ) . . . . .                                                                                                                                                                                                                   | 043113 |
| Peng Qin, Long Xu, Min Gong, Weiping Wan, Zhenghua Yao, Yu Lei, Lingling Zheng, Xufei Sun, and Zhanghai Chen                                                                                                                                                                                                                                                |        |
| Influence of frequency detuning on a four-level heterodyne Rydberg-atom receiver ( <i>11 pages</i> ) . . . . .                                                                                                                                                                                                                                              | 043114 |
| Yu Tang, Chuang Yang, and Shuang Ren                                                                                                                                                                                                                                                                                                                        |        |
|  Simulated laser cooling and magneto-optical trapping of group-IV atoms ( <i>14 pages</i> ) . . . . .                                                                                                                                                                      | 043115 |
| Geoffrey Zheng, Jianwei Wang, Mohit Verma, Qian Wang, Thomas K. Langin, and David DeMille                                                                                                                                                                                                                                                                   |        |
| Time-dependent density-functional-theory study of strong-field laser-induced Coulomb explosion of the HCl dimer ( <i>15 pages</i> ) . . . . .                                                                                                                                                                                                               | 043116 |
| C. Jiang, Cody L. Covington, and Kalman Varga                                                                                                                                                                                                                                                                                                               |        |
| Enantiospecific state transfer on a tight lower bound of energy-time costs ( <i>15 pages</i> ) . . . . .                                                                                                                                                                                                                                                    | 043117 |
| Min-Peng Han, Libin Fu, and Chong Ye                                                                                                                                                                                                                                                                                                                        |        |

(Continued)

# CONTENTS - Continued

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                                                      |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| General properties of the RABBITT scheme at parity-mixing conditions ( <i>12 pages</i> ) . . . . .                                                                                   | 043118 |
| Maria M. Popova, Sergei N. Yudin, Alexei N. Grum-Grzhimailo, and Elena V. Gryzlova                                                                                                   |        |
| State-selective ionization and trapping of single $H_2^+$ ions with $(2 + 1)$ multiphoton ionization ( <i>9 pages</i> ) . . . . .                                                    | 043119 |
| Ho June Kim, Fabian Schmid, David Holzapfel, and Daniel Kienzler                                                                                                                     |        |
| Radiation of relativistic electrons created in tunnel ionization of atomic gases by laser beams of extreme intensity ( <i>10 pages</i> ) . . . . .                                   | 043120 |
| N. V. Makarenko and S. V. Popruzhenko                                                                                                                                                |        |
| Tunneling-ionization-assisted laser-induced electron diffraction for molecular differentiation: From isomers and structural analogs to dynamic systems ( <i>15 pages</i> ) . . . . . | 043121 |
| Su-Ju Wang, C. D. Lin, and Chi-Hong Yuen                                                                                                                                             |        |
| Laser-assisted dynamic interference in double ionization of helium ( <i>10 pages</i> ) . . . . .                                                                                     | 043122 |
| Qiubo Meng, Mingxuan Li, Sizuo Luo, Dajun Ding, Liang-You Peng, and Wei-Chao Jiang                                                                                                   |        |
| Line-shape asymmetry and light shift of the four-level double- $\Lambda$ -scheme coherent-population-trapping resonance ( <i>12 pages</i> ) . . . . .                                | 043123 |
| Takahiro Fujisaku, Kenta Matsumoto, Sota Kagami, Akihiro Kirihara, and Atsuo Morinaga                                                                                                |        |
| High-order above-threshold ionization by squeezed coherent light ( <i>10 pages</i> ) . . . . .                                                                                       | 043124 |
| D. Habibović and D. B. Milošević                                                                                                                                                     |        |
| Nonadiabatic theory for subcycle ionic dynamics in multielectron tunneling ionization ( <i>20 pages</i> ) . . . . .                                                                  | 043125 |
| Chi-Hong Yuen                                                                                                                                                                        |        |
| Directional loss of contrast in temporal double-slit interferometry ( <i>15 pages</i> ) . . . . .                                                                                    | 043126 |
| M. A. H. B. Md Yusoff, H. B. Ambalampitiya, and J. M. Ngoko Djiokap                                                                                                                  |        |
| Dipole-phase evolution of laser-dressed autoionizing states in neon ( <i>8 pages</i> ) . . . . .                                                                                     | 043127 |
| Sean Marshallsay, Hugo W. van der Hart, and Andrew C. Brown                                                                                                                          |        |
| Coherent control of quantum states by quadratically chirped short laser pulses ( <i>11 pages</i> ) . . . . .                                                                         | 043128 |
| G. P. Djotyan, A. A. Avetisyan, and A. P. Djotyan                                                                                                                                    |        |

## PART C

### Ultracold systems and matter waves

|                                                                                                                                                     |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Emergent topological properties in spatially modulated sub-wavelength-barrier lattices ( <i>10 pages</i> ) . . . . .                                | 043301 |
| Giedrius Žlabys, Wen-Bin He, Domantas Burba, Sarika Sasidharan Nair, Thomas Busch, and Tomoki Ozawa                                                 |        |
| Free energy of the gas of spin-1/2 fermions beyond the second order and the Stoner phase transition ( <i>16 pages</i> ) . . . . .                   | 043302 |
| Oskar Grocholski and Piotr H. Chankowski                                                                                                            |        |
| Quantum-gas microscopy and Talbot interferometry of the Bose-glass phase ( <i>9 pages</i> ) . . . . .                                               | 043303 |
| Lennart Koehn, Christopher Parsonage, Callum W. Duncan, Peter Kirton, Andrew J. Daley, Timon Hilker, Elmar Haller, Arthur La Rooij, and Stefan Kuhr |        |
| Lattice-enabled detection of spin-dependent three-body interactions ( <i>11 pages</i> ) . . . . .                                                   | 043304 |
| C. Binegar, J. O. Austin-Harris, S. E. Begg, P. Sigdel, T. Bilitewski, and Y. Liu                                                                   |        |

(Continued)

# CONTENTS - *Continued*

| PHYSICAL REVIEW A                                                                                                                                                          | THIRD SERIES, VOLUME 113, NUMBER 4 | APRIL 2026 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|
| Extreme dynamics and relaxation of quantum gases: A hydrodynamic approach ( <i>14 pages</i> ) . . . . .                                                                    |                                    | 043305     |
| Ritwik Mukherjee, Abhishek Dhar, Manas Kulkarni, and Samriddhi Sankar Ray                                                                                                  |                                    |            |
| Self-consistent inclusion of disorder in the BCS-BEC crossover near the critical temperature ( <i>9 pages</i> ) . . . . .                                                  |                                    | 043306     |
| M. Iskin                                                                                                                                                                   |                                    |            |
| Band structure of a coupled Bose-Einstein-condensate–cavity system: Effects of dissipation and geometry ( <i>13 pages</i> ) . . . . .                                      |                                    | 043307     |
| David Baur, Simon Hertlein, Alexander Baumgärtner, Justyna Stefaniak, Tilman Esslinger, Gabriele Natale, and Tobias Donner                                                 |                                    |            |
| Quench-induced collective excitations: From breathing to acoustic modes ( <i>7 pages</i> ) . . . . .                                                                       |                                    | 043308     |
| Shicong Song, Ke Wang, Zhengli Wu, Andreas Glatz, K. Levin, and Han Fu                                                                                                     |                                    |            |
| Bloch oscillations of a mobile impurity in a one-dimensional Bose gas ( <i>12 pages</i> ) . . . . .                                                                        |                                    | 043309     |
| Saptarshi Majumdar and Aleksandra Petković                                                                                                                                 |                                    |            |
| Finite-temperature phase diagram and collective modes of coherently coupled Bose mixtures ( <i>13 pages</i> ) . . . . .                                                    |                                    | 043310     |
| Sunilkumar V, Rajat, Sandeep Gautam, and Arko Roy                                                                                                                          |                                    |            |
| Evaporative damping in open system theory of Bose-Einstein condensates ( <i>18 pages</i> ) . . . . .                                                                       |                                    | 043311     |
| Nils A. Krause and Ashton S. Bradley                                                                                                                                       |                                    |            |
| Scattering of a weakly bound dimer from a hard wall in one dimension ( <i>8 pages</i> ) . . . . .                                                                          |                                    | 043312     |
| Xican Zhang and Shina Tan                                                                                                                                                  |                                    |            |
| Scattering problem in Bose-Einstein condensates with magnetic domain walls ( <i>10 pages</i> ) . . . . .                                                                   |                                    | 043313     |
| Mei Zhao, Lijia Jiang, Tao Yang, and Jun-Hui Zheng                                                                                                                         |                                    |            |
| Dynamical signatures of Floquet topology in wave-packet dynamics ( <i>9 pages</i> ) . . . . .                                                                              |                                    | 043314     |
| Xin Shen, Bing Lu, and Yan-Qing Zhu                                                                                                                                        |                                    |            |
| Bulk modulus of three-dimensional quantum droplets ( <i>9 pages</i> ) . . . . .                                                                                            |                                    | 043315     |
| Zibin Zhao, Guilong Li, Zhaopin Chen, Huan-Bo Luo, Bin Liu, Boris A. Malomed, and Yongyao Li                                                                               |                                    |            |
| Dynamical localization of interacting ultracold atoms in one-dimensional quasiperiodic potentials ( <i>16 pages</i> ) . . . . .                                            |                                    | 043316     |
| Áttis V. M. Marino, M. A. Caracanhas, V. S. Bagnato, and B. Chakrabarti                                                                                                    |                                    |            |
| Bound state in the continuum induced by second-order skin effects in a topological subspace ( <i>9 pages</i> ) . . . . .                                                   |                                    | 043317     |
| Jin Liu, Zhao-Fan Cai, Yi-Xiao Cheng, Hao Wang, and Tao Liu                                                                                                                |                                    |            |
| Compact detector for atom-atom correlations on an atom chip ( <i>12 pages</i> ) . . . . .                                                                                  |                                    | 043318     |
| Conny Glaser, Dominik Jakab, Florian Jessen, Manuel Kaiser, József Fortágh, and Andreas Günther                                                                            |                                    |            |
| Josephson dynamics of two-dimensional Bose-Einstein condensates in a dual-core trap: Homogeneous, droplet-droplet, and vortex-vortex regimes ( <i>19 pages</i> ) . . . . . |                                    | 043319     |
| Sherzod R. Otajonov and Fatkhulla Kh. Abdullaev                                                                                                                            |                                    |            |
| Canonical approach to quantum fluctuations ( <i>23 pages</i> ) . . . . .                                                                                                   |                                    | 043320     |
| Joanna Ruhl, Vanja Dunjko, and Maxim Olshanii                                                                                                                              |                                    |            |
| <b>Photonics, nonlinear optics, and optomechanics</b>                                                                                                                      |                                    |            |
| Distinct Berry phases in a single triangular Möbius microwave resonator ( <i>6 pages</i> ) . . . . .                                                                       |                                    | 043501     |
| E. C. I. Paterson, M. E. Tobar, M. Goryachev, and J. Bourhill                                                                                                              |                                    |            |

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                                          |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Ultrahigh gain generated by four-wave optical parametric amplification in a coupled quantum-dot-metallic-nanoshell system ( <i>10 pages</i> ) . . . . .                  | 043502 |
| Wen-Hao Zhao, Jian-Bo Li, Hong-Mei Gong, Si Xiao, Jin-Bo Hu, and Yu-Xiang Peng                                                                                           |        |
| Phonon-induced two-axis spin squeezing with decoherence reduction in a hybrid spin-optomechanical system ( <i>15 pages</i> ) . . . . .                                   | 043503 |
| Feng Qiao and Zu-Jian Ying                                                                                                                                               |        |
| True and apparent motion of optomechanical resonators, with applications to feedback cooling of gravitational-wave-detector test masses ( <i>22 pages</i> ) . . . . .    | 043504 |
| Evan D. Hall and Kevin Kuns                                                                                                                                              |        |
| Vectorial light in Fabry-Pérot resonators in the normal-dispersion regime ( <i>21 pages</i> ) . . . . .                                                                  | 043505 |
| Graeme N. Campbell, Lewis Hill, Pascal Del'Haye, and Gian-Luca Oppo                                                                                                      |        |
| Gapless topological doublons in the periodically driven extended non-Hermitian two-particle Bose-Hubbard model ( <i>9 pages</i> ) . . . . .                              | 043506 |
| Huan-Yu Wang and Wu-Ming Liu                                                                                                                                             |        |
| Influence of atomic diffusion on the shape of electromagnetically induced transparency resonance in a gas cell with a buffer gas ( <i>11 pages</i> ) . . . . .           | 043507 |
| K. A. Barantsev, G. V. Voloshin, A. N. Litvinov, and E. K. Rozhkov                                                                                                       |        |
| Generation of subfemtosecond deep and vacuum UV pulses via two-photon Rabi oscillations in alkali-metal atoms or alkaline-earth-metal ions ( <i>19 pages</i> ) . . . . . | 043508 |
| I. R. Khairulin, A. A. Romanov, A. A. Silaev, M. Yu. Ryabikin, and V. A. Antonov                                                                                         |        |
| Enhanced third-order cross-nonlinearity in four-level and three-level systems ( <i>10 pages</i> ) . . . . .                                                              | 043509 |
| Yifan Yao, Yupeng Duan, and Yingjie Du                                                                                                                                   |        |
| Silicon-on-insulator-compatible degenerate-band-edge photonic structure: Design rules and robustness analysis ( <i>9 pages</i> ) . . . . .                               | 043510 |
| Kessem Zamir-Abramovich and Jacob Scheuer                                                                                                                                |        |
| Controllable polarization rotation of hybrid-order Poincaré solitons in strongly nonlocal media ( <i>9 pages</i> ) . . . . .                                             | 043511 |
| Qing Wang, Yongzheng Xu, Dumitru Mihalache, Milivoj R. Belić, and Qian Shou                                                                                              |        |
| Coherence and dimensionality witnesses for fractional orbital angular momentum modes ( <i>12 pages</i> ) . . . . .                                                       | 043512 |
| A. L. S. Santos Junior, I. Prego, M. Gil de Oliveira, A. C. Barbosa, B. P. da Silva, D. J. Brod, E. F. Galvão, and A. Z. Khoury                                          |        |
| Influence of Kerr anisotropy in parametric amplification ( <i>8 pages</i> ) . . . . .                                                                                    | 043513 |
| Nathan G. Drouillard, Fadi Farook, Meerna Albert, Rachel Durling, Jordan Saad, Jeffrey G. Rau, and TJ Hammond                                                            |        |
| Optical beam propagation inside a graded-index fiber with saturable nonlinearity ( <i>7 pages</i> ) . . . . .                                                            | 043514 |
| Tiyas Das, Anuj Pratim Lara, Samudra Roy, and Govind P. Agrawal                                                                                                          |        |
| Density-gradient-controlled high-order harmonic generation from a plasma on a solid surface irradiated by midinfrared laser pulses ( <i>11 pages</i> ) . . . . .         | 043515 |
| Mikhail V. Rozhko, Nikita V. Yakushkin, Egor F. Astashkin, Yaroslav O. Romanovskii, Aleksandr V. Mitrofanov, Aleksandr A. Voronin, and Dmitry A. Sidorov-Biryukov        |        |

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                                                        |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Topological transitions controlled by the interaction range ( <i>5 pages</i> ) . . . . .                                                                                               | 043516 |
| Vlad Simonyan and Maxim A. Gorklach                                                                                                                                                    |        |
| Low-loss and compact TE-pass polarizer based on metawaveguides in lithium niobate on insulator ( <i>7 pages</i> ) . . . .                                                              | 043517 |
| Jingjing Zhang, Runyu He, Xiaoxian Song, Zijie Dai, Lijing Huang, Yang Liu, Dong Pan, Zhaojian Zhang, Junbo Yang, and Kai Guo                                                          |        |
| Weak-force sensing in an optomechanical system with squeezed light and feedback control ( <i>11 pages</i> ) . . . . .                                                                  | 043518 |
| Doudou Wang, Suqin Hu, Qiang Zhang, and Yongmin Li                                                                                                                                     |        |
| Topological invariants in nonlinear Thouless pumping of solitons ( <i>9 pages</i> ) . . . . .                                                                                          | 043519 |
| Fei-Fei Wu, Xian-Da Zuo, Qing-Qing Zhu, Tao Yuan, Yi-Yi Mao, Chao Zeng, Yi Jiang, Yu-Ao Chen, Jian-Wei Pan, Wei Zheng, and Han-Ning Dai                                                |        |
| Broadband temporal localization and delocalized temporal edge states in time photonic crystals ( <i>16 pages</i> ) . . . . .                                                           | 043520 |
| Junkai Jiang, Hao Hu, Yang Long, Liangliang Liu, Songyan Hou, Dongjue Liu, and Zhuo Li                                                                                                 |        |
| Optical force density in waveguides with broken symmetry ( <i>12 pages</i> ) . . . . .                                                                                                 | 043521 |
| Farhan I. Zahin, Tasin Intisar, Li-Fan Yang, and Kevin J. Webb                                                                                                                         |        |
| Bistability and exact reflectionless states in nonlinear scattering of a Bose-Einstein condensate ( <i>10 pages</i> ) . . . . .                                                        | 043522 |
| Feilong Wang, Jinlin Fan, Ruolin Chai, Zhibin Zhao, and Qiongtao Xie                                                                                                                   |        |
| Emergence of higher-order topology in a loss-embedded kagome lattice ( <i>9 pages</i> ) . . . . .                                                                                      | 043523 |
| Keran Li, Chaohua Wu, Juan Kang, Shuo Liu, Qinglong Zhang, Diyuang Zheng, Wansu Bao, Yanyang Zhou, and Gang Chen                                                                       |        |
| Combination of the discrete Talbot effect with Bloch-Zener oscillations in binary waveguide arrays ( <i>11 pages</i> ) . . .                                                           | 043524 |
| Minh C. Tran, Hue M. Nguyen, Thau X. Nguyen, and Truong X. Tran                                                                                                                        |        |
| Liouvillian exceptional points in quantum brickwork circuits ( <i>9 pages</i> ) . . . . .                                                                                              | 043525 |
| Vladislav Popkov and Mario Salerno                                                                                                                                                     |        |
|  Quasinormal modes in dispersive photonic time crystals ( <i>15 pages</i> ) . . . . .                | 043526 |
| Calvin M. Hooper, Ian R. Hooper, and Simon A. R. Horsley                                                                                                                               |        |
| Tuning coherent perfect absorption in nonlocal anisotropic composite media ( <i>10 pages</i> ) . . . . .                                                                               | 043527 |
| Yifei Sun, Yunhai Tong, Yufeng Dong, Xu Zhang, Wenjing Yu, and Hongli Chen                                                                                                             |        |
| Storage and retrieval of optical skyrmions with topological characteristics ( <i>13 pages</i> ) . . . . .                                                                              | 043528 |
| Jinwen Wang, Xin Yang, Yun Chen, Zhujun Ye, Xinji Zeng, Yongkun Zhou, Shuya Zhang, Claire Marie Cisowski, Chengyuan Wang, Katsuya Inoue, Yijie Shen, Sonja Franke-Arnold, and Hong Gao |        |
| <b>Quantum optics</b>                                                                                                                                                                  |        |
| Near-perfect superabsorption in a disordered Dicke quantum battery ( <i>10 pages</i> ) . . . . .                                                                                       | 043701 |
| Xing-Liang Dong, Peng-Bo Li, and Yun-Feng Xiao                                                                                                                                         |        |
| Optimization of narrowband photon pair generation in Doppler-broadened atomic vapors ( <i>12 pages</i> ) . . . . .                                                                     | 043702 |
| Hui-Min Zhao, Xiao-Jun Zhang, Di-Di Zheng, and Jin-Hui Wu                                                                                                                              |        |
| Subcycle tomography of quantum light ( <i>24 pages</i> ) . . . . .                                                                                                                     | 043703 |
| Geehyun Yang, Matthias Kizmann, Alfred Leitenstorfer, and Andrey S. Moskaleiko                                                                                                         |        |

(Continued)

# CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

|                                                                                                                                                                          |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Modeling quantum noise in nanolasers using Markov chains ( <i>17 pages</i> ) . . . . .                                                                                   | 043704 |
| Matias Bundgaard-Nielsen, Gian Luca Lippi, and Jesper Mørk                                                                                                               |        |
| Spin-orbit coupling of optical vector vortices in coherently prepared media ( <i>12 pages</i> ) . . . . .                                                                | 043705 |
| Dharma P. Permana, Mazena Mackoite Sinkevičienė, Julius Ruseckas, and Hamid R. Hamed                                                                                     |        |
| Spectroscopic signatures of emergent elementary excitations in a kinetically constrained long-range interacting two-dimensional spin system ( <i>7 pages</i> ) . . . . . | 043706 |
| Tobias Kaltenmark, Chris Nill, Christian Groß, and Igor Lesanovsky                                                                                                       |        |
| Superradiant Raman scattering with rubidium atoms in an optical cavity: Dynamical dispersive coupling and AC Stark shift effect ( <i>13 pages</i> ) . . . . .            | 043707 |
| Huihui Yu, Gang Chen, Chongxin Shan, and Yuan Zhang                                                                                                                      |        |
| Single-photon superradiance and subradiance in helical collectives of quantum emitters ( <i>14 pages</i> ) . . . . .                                                     | 043708 |
| Hamza Patwa and Philip Kurian                                                                                                                                            |        |
| Manipulating excitation dynamics in structured waveguide quantum electrodynamics ( <i>12 pages</i> ) . . . . .                                                           | 043709 |
| I Gusti Ngurah Yudi Handayana, Ya-Tang Yu, Wei-Hsuan Chung, and H. H. Jen                                                                                                |        |
| Engineering near-unitary one-axis-twisting evolution via a driven Tavis-Cummings model ( <i>10 pages</i> ) . . . . .                                                     | 043710 |
| Jinfeng Liu, Yan Mu, Lili Song, Gang Liu, and Mingfeng Wang                                                                                                              |        |
| Relativistic Maxwell-Bloch equations with applications to astrophysics ( <i>9 pages</i> ) . . . . .                                                                      | 043711 |
| Ningyan Fang, Victor Botez, Fereshteh Rajabi, and Martin Houde                                                                                                           |        |
| Spectroscopy of quantum phase slips: Visualizing complex real-time instantons ( <i>20 pages</i> ) . . . . .                                                              | 043712 |
| Foster Thompson, Daniel K. J. Boneß, Mark Dykman, and Alex Kamenev                                                                                                       |        |
| Analytical and numerical studies of periodic superradiance ( <i>16 pages</i> ) . . . . .                                                                                 | 043713 |
| Hideaki Hara, Yuki Miyamoto, Junseok Han, Riku Omoto, Yasutaka Imai, Akihiro Yoshimi, Koji Yoshimura, Motohiko Yoshimura, and Noboru Sasao                               |        |
| Beats in multipath coherent-population-trapping–Ramsey interferometry and their applications ( <i>13 pages</i> ) . . . . .                                               | 043714 |
| Haihua He, Jiawei Fang, Zhi Tan, Changyue Sun, Min Zhuang, Bo Lu, Chengyin Han, and Chaohong Lee                                                                         |        |
| Coherent polarization self-rotation ( <i>12 pages</i> ) . . . . .                                                                                                        | 043715 |
| Roy Shaham, Orr Meron, Or Katz, Dmitry Yankelev, and Ofer Firstenberg                                                                                                    |        |
| ☞ Directional quantum scattering transducer in cooperative Rydberg metasurfaces ( <i>29 pages</i> ) . . . . .                                                            | 043716 |
| Jonas von Milczewski, Kelly Werker Smith, and Susanne F. Yelin                                                                                                           |        |
| Generalized Schawlow-Townes limit ( <i>9 pages</i> ) . . . . .                                                                                                           | 043717 |
| Hudson Loughlin and Vivashek Sudhir                                                                                                                                      |        |
| Solving Dicke superradiance analytically: A compendium of methods ( <i>12 pages</i> ) . . . . .                                                                          | 043718 |
| R. Holzinger, N. S. Bassler, J. Lyne, F. G. Jimenez, J. T. Gohsrich, and C. Genes                                                                                        |        |
| From squeezed states to sub-Planck structures: Non-Gaussian resources for quantum sensing ( <i>14 pages</i> ) . . . . .                                                  | 043719 |
| S. Dolatshahi and M. K. Tavassoly                                                                                                                                        |        |
| Quantum phase transitions of the anisotropic Dicke-Ising model in driven Rydberg arrays ( <i>12 pages</i> ) . . . . .                                                    | 043720 |
| Bao-Yun Dong, Ying Liang, Stefano Chesi, and Xue-Feng Zhang                                                                                                              |        |

(Continued)

# CONTENTS - *Continued*

| PHYSICAL REVIEW A                                                                                                                                                                  | THIRD SERIES, VOLUME 113, NUMBER 4 | APRIL 2026 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|
| Efficient detection of non-Gaussian states via Wigner-function test (9 pages) . . . . .                                                                                            |                                    | 043721     |
| Jaehak Lee, Jiyong Park, and Hyunchul Nha                                                                                                                                          |                                    |            |
| Phase-preserving control of Floquet-engineered cavity quantum electrodynamics (12 pages) . . . . .                                                                                 |                                    | 043722     |
| Jia-Wang Yu, Xiao-Qing Zhou, Zhi-Bo Ni, Xiao-Tian Cheng, Yi Zhao, Hui-Hui Zhu,<br>Chen-Hui Li, Feng Liu, and Chao-Yuan Jin                                                         |                                    |            |
| Robust population transfer by a detuning sign jump: From two-state quantum systems to SU(2)-symmetric<br>three-state quantum systems (10 pages) . . . . .                          |                                    | 043723     |
| Peter Chernev and Andon A. Rangelov                                                                                                                                                |                                    |            |
| Superradiant and subradiant linewidth engineering for quantum-enhanced microwave sensing with Rydberg<br>atoms (9 pages) . . . . .                                                 |                                    | 043724     |
| Rui Chen, Dong-Yang Wang, Shi-Lei Su, and Gao-Xiang Li                                                                                                                             |                                    |            |
| Circumventing the no-go theorem for superradiant phase transition in a three-level quantum Rabi dimer<br>model (8 pages) . . . . .                                                 |                                    | 043725     |
| Wen-Bo Li, Yan Zhang, Jianxun Hu, Chen-Zhong Dong, and Jun Jiang                                                                                                                   |                                    |            |
| Correlated photon emission by two excited giant atoms coupled to a one-dimensional waveguide (13 pages) . . . . .                                                                  |                                    | 043726     |
| Wenju Gu, Liangbin He, Zhen Yi, Lihui Sun, Guang-Ming Huang, and Gao-xiang Li                                                                                                      |                                    |            |
| Resonant cavity QED with chiral flat bands (9 pages) . . . . .                                                                                                                     |                                    | 043727     |
| E. M. Broni, A. M. C. Souza, M. L. Lyra, F. A. B. F. de Moura, and G. M. A. Almeida                                                                                                |                                    |            |
| Entanglement dynamics of multi-level atoms embedded in photonic crystals: Leveraging resonant dipole-dipole<br>interactions and quantum interference (13 pages) . . . . .          |                                    | 043728     |
| Nancy Ghangas and Shubhrangshu Dasgupta                                                                                                                                            |                                    |            |
| Numerically exact quantum-simulation approach for two-dimensional spectroscopy of open quantum<br>systems (16 pages) . . . . .                                                     |                                    | 043729     |
| Yi-Xuan Yao (姚依萱), Hao-Yue Zhang (张皓玥), Cheng-Ge Liu (刘承葛), Rong-Hang Chen (陈荣杭),<br>Qing Ai (艾清), and Franco Nori (野理)                                                            |                                    |            |
| Path-integral quantization of the electromagnetic field in nonlinear dielectric materials (12 pages) . . . . .                                                                     |                                    | 043730     |
| Arman Kashef, Oscar Perearnau Herrero, Alexander Szameit, Marco Ornigotti, and Stefan Scheel                                                                                       |                                    |            |
| High-fidelity Raman spin-dependent kicks in the presence of micromotion (16 pages) . . . . .                                                                                       |                                    | 043731     |
| Haonan Liu, Varun D. Vaidya, Monica Gutierrez Galan, Alexander K. Ratcliffe,<br>Amrit Poudel, and C. Ricardo Viteri                                                                |                                    |            |
| Towards an experimental implementation of entanglement harvesting in superconducting circuits:<br>Effect of detector gap variation on entanglement harvesting (36 pages) . . . . . |                                    | 043732     |
| Adam Teixidó-Bonfill, Xi Dai, Adrian Lupascu, and Eduardo Martín-Martínez                                                                                                          |                                    |            |
| Degenerate mirrorless lasing in thermal vapors (9 pages) . . . . .                                                                                                                 |                                    | 043733     |
| Aneesh Ramaswamy, Dmitry Budker, Simon Rochester, Aram Papoyan, Svetlana Shmavonyan,<br>Himadri Parashar, Vladimir V. Malinovsky, and Svetlana A. Malinovskaya                     |                                    |            |

(Continued)

## CONTENTS - *Continued*

PHYSICAL REVIEW A

THIRD SERIES, VOLUME 113, NUMBER 4

APRIL 2026

### ERRATA

|                                                                                                                                                                                                                |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Erratum: Practical noise mitigation for quantum annealing via dynamical decoupling: Toward industry-relevant optimization using trapped ions [Phys. Rev. A <b>113</b> , 012621 (2026)] ( <i>1 page</i> ) ..... | 049901(E) |
| Sebastian Nagies, Chiara Capecci, Marcel Seelbach Benkner, Javed Akram, Sebastian Rubbert,<br>Dimitrios Bantounas, Michael Moeller, Michael Johanning, and Philipp Hauke                                       |           |
| Erratum: Theory of multiqubit superradiance in a waveguide in the presence of finite delay times and two quantum excitations [Phys. Rev. A <b>112</b> , 063702 (2025)] ( <i>2 pages</i> ) .....                | 049902(E) |
| Sofia Arranz Regidor, Franco Nori, and Stephen Hughes                                                                                                                                                          |           |