

# PHYSICAL REVIEW A

For editorial and subscription correspondence,  
please see inside front cover  
(ISSN: 1050-2947)

PERIODICALS  
Postmaster send address changes to:  
American Institute of Physics  
Suite 1NO1  
2 Huntington Quadrangle  
Melville, NY 11747-4502

---

---

THIRD SERIES, VOLUME 62, NUMBER 4

CONTENTS

OCTOBER 2000

---

---

## RAPID COMMUNICATIONS

### Fundamental concepts

- Collective versus local measurements on two parallel or antiparallel spins (*4 pages*) ..... 040101(R)  
S. Massar

### Quantum information

- Optimal  $N$ -to- $M$  cloning of conjugate quantum variables (*3 pages*) ..... 040301(R)  
N. J. Cerf and S. Iblisdir

### Atomic and molecular collisions and interactions

- Bound-free correlation in electron scattering by atoms and molecules (*4 pages*) ..... 040701(R)  
R. K. Nesbet

### Atomic and molecular processes in external fields

- Synthesis and characterization of entangled mesoscopic superpositions for a trapped electron (*4 pages*) ..... 041401(R)  
Michol Massini, Mauro Fortunato, Stefano Mancini, and Paolo Tombesi

### Matter waves

- Low-energy collective excitations in a superfluid trapped Fermi gas (*4 pages*) ..... 041601(R)  
M. A. Baranov and D. S. Petrov

### Quantum optics, physics of lasers, nonlinear optics

- Transverse effects in ring fiber laser multimode instabilities (*3 pages*) ..... 041801(R)  
J. F. Urchueguía, G. J. de Valcárcel, Eugenio Roldán, and F. Prati
- Phase-matched high-order harmonic generation in an ionized medium using a buffer gas of exploding atomic clusters (*4 pages*) ..... 041802(R)  
John W. G. Tisch
- Pulse-length dependence of high-order harmonic generation in dissociating cyclic organic molecules (*4 pages*) ..... 041803(R)  
N. Hay, R. de Nalda, T. Halfmann, K. J. Mendham, M. B. Mason, M. Castillejo, and J. P. Marangos



|                                                                                |           |
|--------------------------------------------------------------------------------|-----------|
| Localization in a random phase-conjugating medium ( <i>4 pages</i> ) . . . . . | 041804(R) |
| M. Blaauboer                                                                   |           |

## ARTICLES

**Fundamental concepts**

|                                                                                                                                                            |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Spin precession and energy conservation ( <i>5 pages</i> ) . . . . .                                                                                       | 042101 |
| Onuttom Narayan                                                                                                                                            |        |
| Interrelations between the neutron's magnetic interactions and the magnetic Aharonov-Bohm effect<br>( <i>6 pages</i> ) . . . . .                           | 042102 |
| E. Comay                                                                                                                                                   |        |
| Radiation pressure as a source of decoherence ( <i>11 pages</i> ) . . . . .                                                                                | 042103 |
| Paulo A. Maia Neto and Diego A. R. Dalvit                                                                                                                  |        |
| Back reaction of clocks and limitations on observability in closed systems ( <i>7 pages</i> ) . . . . .                                                    | 042104 |
| Aharon Casher and Benni Reznik                                                                                                                             |        |
| Quantum theory of a Stern-Gerlach system in contact with a linearly dissipative environment ( <i>8 pages</i> ) . . . . .                                   | 042105 |
| Subhashish Banerjee and R. Ghosh                                                                                                                           |        |
| Quantum transitions and nonlocality ( <i>15 pages</i> ) . . . . .                                                                                          | 042106 |
| T. Petrosky, G. Ordonez, and I. Prigogine                                                                                                                  |        |
| Average dwell time and tunneling ( <i>5 pages</i> ) . . . . .                                                                                              | 042107 |
| H. M. Nussenzveig                                                                                                                                          |        |
| Disagreement between correlations of quantum mechanics and stochastic electrodynamics in the damped<br>parametric oscillator ( <i>16 pages</i> ) . . . . . | 042108 |
| D. T. Pope, P. D. Drummond, and W. J. Munro                                                                                                                |        |
| Semiclassical trace formulas for two identical particles ( <i>15 pages</i> ) . . . . .                                                                     | 042109 |
| Jamal Sakhr and Niall D. Whelan                                                                                                                            |        |
| Barnett-Pegg formalism of angle operators, revivals, and flux lines ( <i>3 pages</i> ) . . . . .                                                           | 042110 |
| Arul Lakshminarayan                                                                                                                                        |        |

**Quantum information**

|                                                                                                     |        |
|-----------------------------------------------------------------------------------------------------|--------|
| Enhanced quantum estimation via purification ( <i>5 pages</i> ) . . . . .                           | 042301 |
| Holger Mack, Dietmar G. Fischer, and Matthias Freyberger                                            |        |
| Probabilistic quantum cloning via Greenberger-Horne-Zeilinger states ( <i>8 pages</i> ) . . . . .   | 042302 |
| Chuan-Wei Zhang, Chuan-Feng Li, Zi-Yang Wang, and Guang-Can Guo                                     |        |
| Optically simulating a quantum associative memory ( <i>6 pages</i> ) . . . . .                      | 042303 |
| John C. Howell, John A. Yeazell, and Dan Ventura                                                    |        |
| Quantum copying can increase the practically available information ( <i>9 pages</i> ) . . . . .     | 042304 |
| P. Deuar and W. J. Munro                                                                            |        |
| Speed of ion-trap quantum-information processors ( <i>9 pages</i> ) . . . . .                       | 042305 |
| A. Steane, C. F. Roos, D. Stevens, A. Mundt, D. Leibfried, F. Schmidt-Kaler, and R. Blatt           |        |
| Complete separability and Fourier representations of $n$ -qubit states ( <i>5 pages</i> ) . . . . . | 042306 |
| Arthur O. Pittenger and Morton H. Rubin                                                             |        |
| Fast quantum gates for cold trapped ions ( <i>10 pages</i> ) . . . . .                              | 042307 |
| D. Jonathan, M. B. Plenio, and P. L. Knight                                                         |        |
| Conditional teleportation using optical squeezers and photon counting ( <i>5 pages</i> ) . . . . .  | 042308 |
| Jens Clausen, Tomáš Opatrný, and Dirk-Gunnar Welsch                                                 |        |
| Quantum rate-distortion coding ( <i>6 pages</i> ) . . . . .                                         | 042309 |
| Howard Barnum                                                                                       |        |

|                                                                                     |        |
|-------------------------------------------------------------------------------------|--------|
| Inconclusive rate as a disturbance measure in quantum cryptography (14 pages) ..... | 042310 |
| Howard E. Brandt                                                                    |        |
| Quantum communication with correlated nonclassical states (8 pages) .....           | 042311 |
| S. F. Pereira, Z. Y. Ou, and H. J. Kimble                                           |        |

**Atomic and molecular structure and dynamics**

|                                                                                                                                                                                                  |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Absolute measurement of the resonance lines in heliumlike vanadium on an electron-beam ion trap (13 pages) .....                                                                                 | 042501 |
| C. T. Chantler, D. Paterson, L. T. Hudson, F. G. Serpa, J. D. Gillaspay, and E. Takács                                                                                                           |        |
| Accuracy of the Krieger-Li-Iafrate approximation for molecules (6 pages) .....                                                                                                                   | 042502 |
| E. Engel, A. Höck, and R. M. Dreizler                                                                                                                                                            |        |
| Molecular deformation in the $O\ 1s^{-1}2\pi_u$ excited states of $CO_2$ probed by the triple-differential measurement of fragment ions (5 pages) .....                                          | 042503 |
| N. Saito, K. Ueda, M. Simon, K. Okada, Y. Shimizu, H. Chiba, Y. Senba, H. Okumura, H. Ohashi, Y. Tamenori, S. Nagaoka, A. Hiraya, H. Yoshida, E. Ishiguro, T. Ibuki, I. H. Suzuki, and I. Koyano |        |
| Calculation of positron binding to silver and gold atoms (7 pages) .....                                                                                                                         | 042504 |
| V. A. Dzuba, V. V. Flambaum, and C. Harabati                                                                                                                                                     |        |
| Anisotropic muonium atoms: Energy levels and electron spin exchange (21 pages) .....                                                                                                             | 042505 |
| Masayoshi Senba                                                                                                                                                                                  |        |
| Hyperfine-structure intervals and isotope shifts in the $2p^33s\ ^5S_2 \rightarrow 2p^33p\ ^5P_J$ transitions of atomic oxygen (6 pages) .....                                                   | 042506 |
| R. M. Jennerich and D. A. Tate                                                                                                                                                                   |        |
| Relativistic many-body calculations of transition amplitudes for berylliumlike ions (14 pages) .....                                                                                             | 042507 |
| Hsiang-Shun Chou                                                                                                                                                                                 |        |
| Relativistic magnetic quadrupole transitions in Be-like ions (6 pages) .....                                                                                                                     | 042508 |
| Sonjoy Majumder and B. P. Das                                                                                                                                                                    |        |
| Spectroscopic investigation of the double-minimum $2\ ^1\Sigma_u^+$ state of the potassium dimer (4 pages) .....                                                                                 | 042509 |
| W. Jastrzebski, W. Jaśniecki, P. Kowalczyk, R. Nadyak, and A. Pashov                                                                                                                             |        |

**Atomic and molecular collisions and interactions**

|                                                                                                                                                                                                   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Ionization of hydrogen atoms by fast electrons (10 pages) .....                                                                                                                                   | 042701 |
| S. Jones and D. H. Madison                                                                                                                                                                        |        |
| Rigorous mathematical study of the He bound states (9 pages) .....                                                                                                                                | 042702 |
| Yu. V. Popov and L. U. Ancarani                                                                                                                                                                   |        |
| Polarizability of Rydberg atoms and the dominant long-range interactions (7 pages) .....                                                                                                          | 042703 |
| Yukap Hahn                                                                                                                                                                                        |        |
| Time-dependent screening effects in ion-atom collisions with many active electrons (13 pages) .....                                                                                               | 042704 |
| T. Kirchner, M. Horbatsch, H. J. Lüdde, and R. M. Dreizler                                                                                                                                        |        |
| Time-dependent close-coupling calculations for the electron-impact ionization of carbon and neon (6 pages) .....                                                                                  | 042705 |
| M. S. Pindzola, J. Colgan, F. Robicheaux, and D. C. Griffin                                                                                                                                       |        |
| Hyperspherical calculations of $H(1s) + \mu^+$ rearrangement collision cross sections from threshold to 2 eV (5 pages) .....                                                                      | 042706 |
| Z. X. Zhao, A. Igarashi, and C. D. Lin                                                                                                                                                            |        |
| Resonant ion-pair formation in electron collisions with $HD^+$ and $OH^+$ (8 pages) .....                                                                                                         | 042707 |
| Å. Larson, N. Djurić, W. Zong, C. H. Greene, A. E. Orel, A. Al-Khalili, A. M. Derkach, A. Le Padellec, A. Neau, S. Rosén, W. Shi, L. Viktor, H. Danared, M. af Ugglas, M. Larsson, and G. H. Dunn |        |

|                                                                                                                                                               |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Dissociative ionization of $D_2$ in intense laser fields: $D^+$ -ion production perpendicular to the polarization of a 400-nm laser field (3 pages) . . . . . | 042708 |
| A. Talebpour, K. Vijayalakshmi, A. D. Bandrauk, T. T. Nguyen-Dang, and S. L. Chin                                                                             |        |
| Measurement of charge-transfer-rate coefficients of ground-state $He^+$ with $N_2$ and $CH_4$ at electron-volt energies (6 pages) . . . . .                   | 042709 |
| Z. Fang, D. Chen, and Victor H. S. Kwong                                                                                                                      |        |
| Two-state model for top-of-barrier processes (12 pages) . . . . .                                                                                             | 042710 |
| R. S. Tantawi, A. S. Sabbah, J. H. Macek, and S. Yu. Ovchinnikov                                                                                              |        |
| Classical overbarrier model to compute charge exchange and ionization between ions and one-optical-electron atoms (10 pages) . . . . .                        | 042711 |
| Fabio Sattin                                                                                                                                                  |        |
| Interelectronic-interaction effect on the radiative recombination of an electron with a heavy He-like ion (9 pages) . . . . .                                 | 042712 |
| V. A. Yerokhin, V. M. Shabaev, T. Beier, and J. Eichler                                                                                                       |        |
| <b>Photon, electron, atom, and molecule interactions with solids and surfaces</b>                                                                             |        |
| Sputtering of hollow atoms from carbon surfaces (7 pages) . . . . .                                                                                           | 042901 |
| T. Schlathölter, A. Nürmann, A. Robin, D. F. A. Winters, S. Marini, R. Morgenstern, and R. Hoekstra                                                           |        |
| <b>Clusters (including fullerenes)</b>                                                                                                                        |        |
| Surface- and volume-plasmon excitations in electron inelastic scattering on metal clusters (8 pages) . . . . .                                                | 043201 |
| Leonid G. Gerchikov, Andrey N. Ipatov, Roman G. Polozkov, and Andrey V. Solov'yov                                                                             |        |
| Simulation of MeV/atom cluster correlations in matter (10 pages) . . . . .                                                                                    | 043202 |
| J. W. Hartman, T. A. Tombrello, S. Bouneau, S. Della Negra, D. Jacquet, Y. Le Beyec, and M. Pautrat                                                           |        |
| <b>Atomic and molecular processes in external fields</b>                                                                                                      |        |
| Semiclassical theory of weighted spectra for regular systems: Absorption spectra and decay rates (19 pages) . . . . .                                         | 043401 |
| M. W. Beims, V. Kondratovich, and J. B. Delos                                                                                                                 |        |
| Kicked Rydberg atom: Response to trains of unidirectional and bidirectional impulses (9 pages) . . . . .                                                      | 043402 |
| B. E. Tannian, C. L. Stokely, F. B. Dunning, C. O. Reinhold, S. Yoshida, and J. Burgdörfer                                                                    |        |
| Sensitive magnetometry based on nonlinear magneto-optical rotation (7 pages) . . . . .                                                                        | 043403 |
| D. Budker, D. F. Kimball, S. M. Rochester, V. V. Yashchuk, and M. Zolotarev                                                                                   |        |
| Selective field ionization in Li and Rb: Theory and experiment (7 pages) . . . . .                                                                            | 043404 |
| F. Robicheaux, C. Wesdorp, and L. D. Noordam                                                                                                                  |        |
| Dark state in ruby: Analysis of the feasibility (12 pages) . . . . .                                                                                          | 043405 |
| R. N. Shakhmuratov, A. Szabo, G. Kozyreff, R. Coussement, J. Odeurs, and Paul Mandel                                                                          |        |
| Theory of an optical dipole trap for cold atoms (11 pages) . . . . .                                                                                          | 043406 |
| B. M. Garraway and V. G. Minogin                                                                                                                              |        |
| Coherent population trapping under bichromatic fields (5 pages) . . . . .                                                                                     | 043407 |
| R.G. Unanyan, S. Guérin, and H.R. Jauslin                                                                                                                     |        |
| Ion-recoil momentum spectroscopy in a laser-cooled atomic sample (8 pages) . . . . .                                                                          | 043408 |
| Steffen Wolf and Hanspeter Helm                                                                                                                               |        |
| Classically forbidden recurrences in the photoabsorption spectrum of lithium (7 pages) . . . . .                                                              | 043409 |
| Vladimir Kondratovich, John B. Delos, Neal Spellmeyer, and Daniel Kleppner                                                                                    |        |

|                                                                                                                                                                                          |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Integrals of motion and quantum operators for hydrogenic atoms in external fields ( <i>12 pages</i> ) . . . . .                                                                          | 043410 |
| Marcus W. Beims and Jason A. C. Gallas                                                                                                                                                   |        |
| <b>Matter waves</b>                                                                                                                                                                      |        |
| Fermi-Pasta-Ulam problem revisited with a Bose-Einstein condensate ( <i>11 pages</i> ) . . . . .                                                                                         | 043601 |
| Pierre Villain and Maciej Lewenstein                                                                                                                                                     |        |
| Bound mode of an atom laser ( <i>8 pages</i> ) . . . . .                                                                                                                                 | 043602 |
| John Jeffers, Peter Horak, Stephen M. Barnett, and Paul M. Radmore                                                                                                                       |        |
| Boson correlation energies and density matrices from reduced Hamiltonian interpolation ( <i>10 pages</i> ) . . . . .                                                                     | 043603 |
| David A. Mazziotti and Dudley R. Herschbach                                                                                                                                              |        |
| Loading a continuous-wave atom laser by optical pumping techniques ( <i>6 pages</i> ) . . . . .                                                                                          | 043604 |
| Satyan Bhongale and Murray Holland                                                                                                                                                       |        |
| Atom loss and the formation of a molecular Bose-Einstein condensate by Feshbach resonance ( <i>12 pages</i> ) . . .                                                                      | 043605 |
| V. A. Yurovsky, A. Ben-Reuven, P. S. Julienne, and C. J. Williams                                                                                                                        |        |
| <b>Quantum optics, physics of lasers, nonlinear optics</b>                                                                                                                               |        |
| Sensitivity to measurement perturbation of single-atom dynamics in cavity QED ( <i>6 pages</i> ) . . . . .                                                                               | 043801 |
| X. M. Liu, M. Hug, and G. J. Milburn                                                                                                                                                     |        |
| Bloch waves and Wannier functions in periodic superstructure Bragg gratings ( <i>9 pages</i> ) . . . . .                                                                                 | 043802 |
| I. Talanina and C. Martijn de Sterke                                                                                                                                                     |        |
| Entanglement transformation at absorbing and amplifying four-port devices ( <i>11 pages</i> ) . . . . .                                                                                  | 043803 |
| S. Scheel, L. Knöll, T. Opatrný, and D.-G. Welsch                                                                                                                                        |        |
| Dielectric cavity QED between photonic crystals: An effective uniaxial medium approach ( <i>9 pages</i> ) . . . . .                                                                      | 043804 |
| Ali Kamli and M. Babiker                                                                                                                                                                 |        |
| Field-gradient-induced second-harmonic generation in magnetized vacuum ( <i>9 pages</i> ) . . . . .                                                                                      | 043805 |
| A. E. Kaplan and Y. J. Ding                                                                                                                                                              |        |
| Feedback control and nonlinear intensity noise of Nd:YVO <sub>4</sub> microchip lasers ( <i>12 pages</i> ) . . . . .                                                                     | 043806 |
| A. Bramati, J.-P. Hermier, V. Jost, and E. Giacobino                                                                                                                                     |        |
| Parametric amplification and squeezing of a mode-locked pulse train: A comparison of MgO:LiNbO <sub>3</sub> with bulk periodically poled LiNbO <sub>3</sub> ( <i>9 pages</i> ) . . . . . | 043807 |
| E. M. Daly and A. I. Ferguson                                                                                                                                                            |        |
| Two-color transient pumping in Ni-like silver at 13.9 and 16.1 nm ( <i>7 pages</i> ) . . . . .                                                                                           | 043808 |
| Jaroslav Kuba, Annie Klisnick, David Ros, Paul Fourcade, Gérard Jamelot, Jean-Luc Miquel, Nathalie Blanchot, and Jean-François Wyart                                                     |        |
| Controlling nonclassical properties of the Jaynes-Cummings model by an external coherent field ( <i>6 pages</i> ) . . . . .                                                              | 043809 |
| Fu-li Li and Shao-yan Gao                                                                                                                                                                |        |
| Engineering cavity-field states by projection synthesis ( <i>5 pages</i> ) . . . . .                                                                                                     | 043810 |
| R. M. Serra, N. G. de Almeida, C. J. Villas-Bôas, and M. H. Y. Moussa                                                                                                                    |        |
| Triplet structure in the spontaneous-emission spectrum of two coupled vertical-cavity semiconductor lasers ( <i>4 pages</i> ) . . . . .                                                  | 043811 |
| S. F. Pereira, M. P. van Exter, and J. P. Woerdman                                                                                                                                       |        |
| Nonlinear dynamical evolution of the driven two-photon Jaynes-Cummings model ( <i>7 pages</i> ) . . . . .                                                                                | 043812 |
| Amitabh Joshi                                                                                                                                                                            |        |
| Microscopic model of quantum noise in single-mode semiconductor lasers ( <i>20 pages</i> ) . . . . .                                                                                     | 043813 |
| M. Travagnin and L. A. Lugiato                                                                                                                                                           |        |
| Quantum-state tomography using phase-sensitive amplification ( <i>6 pages</i> ) . . . . .                                                                                                | 043814 |
| Mashhood Ahmad, Shahid Qamar, and M. Suhail Zubairy                                                                                                                                      |        |

|                                                                                                                    |        |
|--------------------------------------------------------------------------------------------------------------------|--------|
| Maxwell-Bloch modeling of x-ray-laser-signal buildup in single- and double-pass configurations<br>(13 pages) ..... | 043815 |
| O. Larroche, D. Ros, A. Klisnick, A. Sureau, C. Möller, and H. Guennou                                             |        |
| Duality between partial coherence and partial entanglement (15 pages) .....                                        | 043816 |
| Bahaa E. A. Saleh, Ayman F. Abouraddy, Alexander V. Sergienko, and Malvin C. Teich                                 |        |
| Self-trapping of electromagnetic beams in vacuum supported by QED nonlinear effects (6 pages) .....                | 043817 |
| Marin Soljačić and Mordechai Segev                                                                                 |        |
| Allowed and forbidden transitions in an atom placed near an ideally conducting cylinder (14 pages) .....           | 043818 |
| V. V. Klimov and M. Ducloy                                                                                         |        |
| Dynamics of atom-mediated photon-photon scattering (10 pages) .....                                                | 043819 |
| M. W. Mitchell, Cindy I. Hancox, and R. Y. Chiao                                                                   |        |
| Temporal indistinguishability and quantum interference (4 pages) .....                                             | 043820 |
| Yoon-Ho Kim, Vincenzo Berardi, Maria V. Chekhova, Augusto Garuccio, and Yanhua Shih                                |        |
| Time-resolved spatiotemporal dynamics in a broad-area CO <sub>2</sub> laser (11 pages) .....                       | 043821 |
| F. Encinas-Sanz, I. Leyva, and J. M. Guerra                                                                        |        |

**BRIEF REPORTS****Quantum information**

|                                                                |        |
|----------------------------------------------------------------|--------|
| Shared access to quantum information (3 pages) .....           | 044301 |
| Stig Stenholm and Erika Andersson                              |        |
| Local and nonlocal properties of Werner states (3 pages) ..... | 044302 |
| Tohya Hiroshima and Satoshi Ishizaka                           |        |

**Atomic and molecular structure and dynamics**

|                                                                                 |        |
|---------------------------------------------------------------------------------|--------|
| Wave-function–density relationship in density-functional theory (3 pages) ..... | 044501 |
| Tamás Gál                                                                       |        |

**Atomic and molecular collisions and interactions**

|                                                                                                                                          |        |
|------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Metastable states of a coupled pair on a repulsive barrier (4 pages) .....                                                               | 044701 |
| F. M. Pen'kov                                                                                                                            |        |
| Energy dependence of the total cross section for electron scattering by chloromethanes in the energy range<br>0.5–10 keV (3 pages) ..... | 044702 |
| G. García and F. Blanco                                                                                                                  |        |

**Clusters (including fullerenes)**

- Hybrid density-functional study of  $\text{Si}_{13}$  clusters (*4 pages*) ..... 045201  
 Ke Deng, Jinlong Yang, Lanfeng Yuan, and Qingshi Zhu

**Atomic and molecular processes in external fields**

- Harmonic linear Paul trap: Stability diagram and effective potentials (*4 pages*) ..... 045401  
 M. Drewsen and A. Br  ner
- Macroscopic quantum states of a trapped ion (*4 pages*) ..... 045402  
 Heping Zeng and Sing Hai Tang

**ERRATA**

- Erratum: Dipolar relaxation collisions in magnetically trapped  $^7\text{Li}$  [Phys. Rev. A **59**, 1514 (1999)]  
 (*1 page*) ..... 049901(E)  
 J. M. Gerton, C. A. Sackett, B. J. Frew, and R. G. Hulet

**Selected Abstracts From Other Physical Review Journals** ..... i

**Cumulative Author Index** ..... ii