# 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**
**500 Sunnyside Boulevard**
**Woodbury, NY 11797-2999**

**THIRD SERIES, VOLUME 58, NUMBER 2** ***CONTENTS*** **AUGUST 1998**

## RAPID COMMUNICATIONS

### Atomic and molecular processes in external fields

Population of Stark wave-packet states by cw laser excitation ..... R785
J. F. Baugh, W. P. Garver, C. E. Burkhardt, and J. J. Leventhal
Probability of photoassociation from a quasicontinuum approach ..... R789
Juha Javanainen and Matt Mackie
Semiclassical dynamics of strongly driven systems ..... R793
M. Yu. Ivanov, O. V. Tikhonova, and M. V. Fedorov
Stimulated Raman molecule production in Bose-Einstein condensates ..... R797
P. S. Julienne, K. Burnett, Y. B. Band, and W. C. Stwalley

### Matter waves

Critical temperature and Ginzburg-Landau equation for a trapped Fermi gas ..... R801
M. A. Baranov and D. S. Petrov

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

Theory of shape-preserving short pulses in inhomogeneously broadened three-level media ..... R805
Ashiqur Rahman and J. H. Eberly
Excitability in a nonlinear optical cavity ..... R809
Weiping Lu, Dejin Yu, and Robert G. Harrison

## ARTICLES

### Fundamental concepts

Quantum conditional probability and hidden-variables models ..... 812
James D. Malley
Supersymmetry, shape invariance, and solvability of $A_{N-1}$ and $BC_N$ Calogero-Sutherland model ..... 821
Pijush K. Ghosh, Avinash Khare, and M. Sivakumar
Local description of quantum inseparability ..... 826
Anna Sanpera, Rolf Tarrach, and Guifré Vidal
Geometry of the Hilbert space and the quantum Zeno effect ..... 831
A. K. Pati and S. V. Lawande
Dynamical analysis of seemingly interaction-free measurements ..... 836
A. Luis and L. L. Sánchez-Soto

**Copyright 1998 by The American Physical Society**

*(Continued)*

1050-2947(199808)58:2;1-B

PHYSICAL REVIEW A THIRD SERIES, VOLUME 58, NUMBER 2 AUGUST 1998

Time of arrival in quantum and Bohmian mechanics ..... 840
C. R. Leavens
Weyl functions and their use in the study of quantum interference ..... 848
S. Chountasis and A. Vourdas
Tunneling near the base of a barrier ..... 856
C. Eltschka, H. Friedrich, M. J. Moritz, and J. Trost
Connection between the closeness of classical orbits and the factorization of the radial Schrödinger equation .... 862
Y. F. Liu, W. J. Huo, and J. Y. Zeng
Bures distance between two displaced thermal states ..... 869
Gh.-S. Paraoanu and Horia Scutaru
Nonadiabatic geometric phase in periodic linear systems ..... 872
Y. C. Ge and M. S. Child

**Quantum information**

Volume of the set of separable states ..... 883
Karol Życzkowski, Paweł Horodecki, Anna Sanpera, and Maciej Lewenstein
Quantum robots and environments ..... 893
Paul Benioff
Quantum convolutional error-correcting codes ..... 905
H. F. Chau
Elliptical ion traps and trap arrays for quantum computation ..... 910
Ralph G. DeVoe
Quantum computation and decision trees ..... 915
Edward Farhi and Sam Gutmann

**Atomic and molecular structure and dynamics**

Chiral dissociation dynamics of molecular ratchets: Preferential senses of rotary motion in microscopic systems ..... 929
Kazuhiko Fukui, John H. Frederick, and Joseph I. Cline
Infinity-free semiclassical evaluation of Casimir effects ..... 935
Martin Schaden and Larry Spruch
Influence of nuclear size on QED corrections in hydrogenlike heavy ions ..... 954
T. Beier, P. J. Mohr, H. Persson, and G. Soff
Relativistic optimized-potential method: Exact transverse exchange and Møller-Plesset-based correlation potential ..... 964
E. Engel, A. Facco Bonetti, S. Keller, I. Andrejkovics, and R. M. Dreizler
Relativistic exchange-correlation energy functional: Gauge dependence of the no-pair correlation energy ..... 993
A. Facco Bonetti, E. Engel, R. M. Dreizler, I. Andrejkovics, and H. Müller
Analysis of the electron self-energy for tightly bound electrons ..... 1001
Ingvar Lindgren, Hans Persson, Sten Salomonson, and Per Sunnergren
Relativistic many-body calculations of energy levels, hyperfine constants, and transition rates for sodiumlike ions, $Z=11-16$ ..... 1016
M. S. Safronova, A. Derevianko, and W. R. Johnson
Shapes of pressure- and Doppler-broadened spectral lines in the core and near wings ..... 1029
Roman Ciuryło
Measurement of $L$-shell fluorescence yields of some elements in the atomic range $65 \leqslant Z \leqslant 74$ using photoionization ..... 1040
Önder Şimşek, Oğuz Doğan, Ümit Turgut, and Mehmet Ertuğrul

*(Continued)*

PHYSICAL REVIEW A THIRD SERIES, VOLUME 58, NUMBER 2 AUGUST 1998

Recurrences without closed orbits ..... 1043
F. Robicheaux and J. Shaw
Polarization labeling spectroscopy of the 3 $^1\Pi$ and 6 $^1\Sigma^+$ states in NaK ..... 1048
A. Pashov, I. Jackowska, W. Jastrzębski, and P. Kowalczyk
Radiative corrections to the hyperfine-structure splitting of hydrogenlike systems ..... 1055
P. Sunnergren, H. Persson, S. Salomonson, S. M. Schneider, I. Lindgren, and G. Soff
Relativistic calculations for Fe XXIII: Atomic structure ..... 1070
Chen Guo-xin and P. P. Ong
Nonadiabatic dipole polarizabilities of $H_2^+$ and $D_2^+$ ground states ..... 1082
J. Shertzer and Chris H. Greene
Measurement of the ratio of the cesium *D*-line transition strengths ..... 1087
Robert J. Rafac and Carol E. Tanner
Even-parity triply excited states of lithium ..... 1098
Ying Zhang and Kwong T. Chung
*Ab initio* pseudopotential and density-functional all-electron study of ionization and excitation energies of actinide atoms ..... 1103
Wenjian Liu, Wolfgang Küchle, and Michael Dolg
Magnetic dipole transition rates from measured lifetimes of levels of Be-like and B-like argon ions ..... 1111
D. P. Moehs and D. A. Church
Dynamics on the ground-state potential surfaces of $H_3$ and its isotopomeres from their uv spectra ..... 1115
D. Azinovic, R. Bruckmeier, Ch. Wunderlich, H. Figger, G. Theodorakopoulos, and I. D. Petsalakis
Positronium in crossed electric and magnetic fields: The existence of a long-lived ground state ..... 1129
J. Shertzer, J. Ackermann, and P. Schmelcher
Line shapes of saturated absorption spectroscopy in optically thick media ..... 1139
O. Di Lorenzo-Filho and J. R. Rios Leite

**Atomic and molecular collisions and interactions**

Spin-exchange effects on tensor polarization of deuterium atoms ..... 1146
H. J. Bulten, Z.-L. Zhou, J. F. J. van den Brand, M. Ferro-Luzzi, and J. Lang
Effect of a thermal bath on electronic resonance decay: A numerical path-integral study ..... 1152
Heiko Plöhn, Michael Thoss, Manfred Winterstetter, and Wolfgang Domcke
*Ab initio* molecular treatment of charge transfer by $Si^{4+}$ ions in helium ..... 1162
M. C. Bacchus-Montabonel and P. Ceyzeriat
Hyperspherical close-coupling study of hyperfine transitions in low-energy $p+p\mu$ and $e^{\pm}+$Ps scattering ..... 1166
Akinori Igarashi, Isao Shimamura, and Nobuyuki Toshima
Scattering of low-energy electrons by polar molecules: An analytic approach ..... 1174
J. Gómez-Camacho, F. Pérez-Bernal, and J. M. Arias
Relativistic calculations for Fe XXIII: Electron-impact excitation ..... 1183
Chen Guo-xin and P. P. Ong
Nonstationary theory of wave-packet potential scattering ..... 1195
D. R. Bitouk and M. V. Fedorov
Absolute measurements of electron-loss cross sections of $He^+$ and $C^{3+}$ with atomic hydrogen at intermediate velocities ..... 1204
M. M. Sant'Anna, W. S. Melo, A. C. F. Santos, G. M. Sigaud, E. C. Montenegro, M. B. Shah, and W. E. Meyerhof
Inner radiation emitted during $\beta^{\pm}$ decay and related problems ..... 1212
Alexei M. Frolov and Vedene H. Smith, Jr.
Electron correlations in *L*-subshell photoionization of intermediate-*Z* elements ($47 \leqslant Z \leqslant 51$) ..... 1221
W. Jitschin and R. Stötzel

*(Continued)*

PHYSICAL REVIEW A THIRD SERIES, VOLUME 58, NUMBER 2 AUGUST 1998

Time-dependent theory of the Auger resonant Raman effect for diatomic molecules: Concepts and model calculations for $N_2$ and CO ..... 1225
Zbigniew W. Gortel, Robert Teshima, and Dietrich Menzel
Long-range interactions of metastable helium atoms ..... 1247
Zong-Chao Yan and J. F. Babb
Electron capture from pair production by $Au^{79+}$ at 10.8 GeV/nucleon ..... 1253
A. Belkacem, N. Claytor, T. Dinneen, B. Feinberg, and Harvey Gould
Kinematic explanation of the observation of very narrow linewidths from dissociative-recombination reactions ... 1256
Kenneth A. Hardy
Angular distributions of projectiles following electron capture from $C_{60}$ by 2.5-keV $Ar^{8+}$ ..... 1261
B. Walch, U. Thumm, M. Stöckli, C. L. Cocke, and S. Klawikowski
Autoionization of a quasicontinuum: Population trapping, self-trapping, and stabilization ..... 1267
Xin Chen and John A. Yeazell
Near-threshold electron-impact excitation of the vacuum-ultraviolet resonance transitions in Ne, Ar, Kr, and Xe ..... 1275
V. Zeman, K. Bartschat, C. Norén, and J. W. McConkey

**Photon, electron, atom, and molecule interactions with solids and surfaces**

Secondary-electron emission from specularly reflected MeV protons ..... 1282
Kenji Kimura, Suguru Ooki, Gou Andou, Kaoru Nakajima, and Michi-hiko Mannami
Dynamical interaction effects on the Coulomb explosion of $H_2^+$ at glancing-angle incidence on solid surfaces ... 1287
You-Nian Wang, Z. L. Mišković, and Wing-Ki Liu

**Atomic and molecular processes in external fields**

Multiphoton ac Stark effect in a bichromatically driven two-level atom ..... 1296
T. G. Rudolph, H. S. Freedhoff, and Z. Ficek
Two-electron atoms in short intense laser pulses ..... 1310
Armin Scrinzi and Bernard Piraux
Strong-field short-pulse photoionization of Rydberg atoms: Interference stabilization and distribution of the photoelectron density in space and time ..... 1322
M. V. Fedorov and O. V. Tikhonova
Ionization via high-Rydberg states with multiple V-type resonances ..... 1335
R. Parzyński and A. Grudka
Nonadiabatic cooling and optimal control in off-resonance dipole optical potentials ..... 1346
A. Bulatov, B. Vugmeister, A. Burin, and H. Rabitz
Laser catalysis with pulses ..... 1352
Amichay Vardi and Moshe Shapiro
Theory of the effect of odd-photon destructive interference on optical shifts in resonantly enhanced multiphoton excitation and ionization ..... 1361
M. G. Payne, Lu Deng, and W. R. Garrett
Intracavity self-induced transparency of a multilevel absorber ..... 1372
M. Müller, V. P. Kalosha, and J. Herrmann
Optimal localization of wave packets on invariant structures ..... 1382
W. Schweizer, W. Jans, and T. Uzer
Observation of collective effects in the multiphoton ionization of atomic deuterium ..... 1389
P. Bowe, F. Giammanco, R. W. O'Neill, P. J. M. van der Burgt, and J. A. Slevin
Photoelectron initial conditions for tunneling ionization in a linearly polarized laser ..... 1399
S. J. McNaught, J. P. Knauer, and D. D. Meyerhofer

*(Continued)*

PHYSICAL REVIEW A THIRD SERIES, VOLUME 58, NUMBER 2 AUGUST 1998

Theory of spin-exchange optical pumping of $^3$He and $^{129}$Xe ..... 1412
S. Appelt, A. Ben-Amar Baranga, C. J. Erickson, M. V. Romalis, A. R. Young, and W. Happer

**Matter waves**

Excitation spectrum and instability of a two-species Bose-Einstein condensate ..... 1440
D. Gordon and C. M. Savage
Thermodynamic properties of an ideal Fermi gas in an external potential with $U=br^t$ in any dimensional space ..... 1445
Mingzhe Li, Zijun Yan, Jincan Chen, Lixuan Chen, and Chuanhong Chen
Quantum kinetic theory. IV. Intensity and amplitude fluctuations of a Bose-Einstein condensate at finite temperature including trap loss ..... 1450
D. Jaksch, C. W. Gardiner, K. M. Gheri, and P. Zoller
Bose-Einstein condensation in an external potential at zero temperature: General theory ..... 1465
Tai Tsun Wu
Precision neutron-interferometric measurement of the coherent neutron-scattering length in silicon ..... 1475
A. Ioffe, D. L. Jacobson, M. Arif, M. Vrana, S. A. Werner, P. Fischer, G. L. Greene, and F. Mezei
Bose-Einstein condensates in spatially periodic potentials ..... 1480
Kirstine Berg-Sørensen and Klaus Mølmer
Bose-Einstein condensation in one-dimensional power-law traps: A path-integral Monte Carlo simulation ..... 1485
Sean Pearson, Tao Pang, and Changfeng Chen
Bose-Einstein condensation of a finite number of particles confined to harmonic traps ..... 1490
R. K. Pathria

**Quantum optics, physics of lasers, nonlinear optics**

Absence of bistable behavior in the optical response of a dimer ..... 1496
V. A. Malyshev, H. Glaeske, and K.-H. Feller
Noise-free quantum-nondemolition measurement using optical solitons ..... 1501
Jean-Michel Courty, Stefan Spälter, Friedrich König, Andreas Sizmann, and Gerd Leuchs
Two-dimensional near-field and far-field imaging of a Ne-like Ar capillary discharge table-top soft-x-ray laser ... 1509
C. H. Moreno, M. C. Marconi, V. N. Shlyaptsev, B. R. Benware, C. D. Macchietto, J. L. A. Chilla, J. J. Rocca, and A. L. Osterheld
Dynamics of a driven two-level atom coupled to a frequency-tunable cavity ..... 1515
Peng Zhou and S. Swain
Emission spectrum in driven two-level systems ..... 1531
Hao Wang, Valder N. Freire, and Xian-Geng Zhao
Semiclassical analysis of the metastable driven and damped quantized anharmonic oscillator ..... 1537
Bjarne Vestergaard and Juha Javanainen
Observation of transient electromagnetically induced transparency in a rubidium $\Lambda$ system ..... 1545
H. X. Chen, A. V. Durrant, J. P. Marangos, and J. A. Vaccaro
Simple vectorial model for the spectrum of a two-level atom in an intense low-frequency field ..... 1549
P. P. Corso, L. Lo Cascio, and F. Persico
Threshold and nonlinear behavior of lasers of $\Lambda$ and V configurations ..... 1559
Gennady A. Koganov and Reuben Shuker
Quasi-one-dimensional character of sound propagation in elongated Bose-Einstein condensed clouds ..... 1563
G. M. Kavoulakis and C. J. Pethick
Two-wave two-wavelength mixing in photochromic molecular systems ..... 1567
D. Dantsker and A. Persoons

*(Continued)*

PHYSICAL REVIEW A THIRD SERIES, VOLUME 58, NUMBER 2 AUGUST 1998

## BRIEF REPORTS

### Fundamental concepts

Exact wave function of a harmonic plus an inverse harmonic potential with time-dependent mass and frequency . . . . . 1574
Chung-In Um, Shang-Moon Shin, Kyu-Hwang Yeon, and Thomas F. George

### Atomic and molecular structure and dynamics

Energy dependence of the molecular-orbital x-ray interference structure in $U^{92+}$-Pb collsions . . . . . 1578
K. Schulze, J. Anton, W.-D. Sepp, and B. Fricke
Kohn-Sham formulation of density-functional theory . . . . . 1581
Abraham Klein and Reiner M. Dreizler
Precision Stark spectroscopy of sodium $^2P$ and $^2D$ states . . . . . 1585
J. F. Baugh, C. E. Burkhardt, J. J. Leventhal, and T. Bergeman

### Atomic and molecular collisions and interactions

High-resolution experimental determination of the angular distribution and spin polarization of xenon $7d'$ and $9s'$ photoelectrons and comparison with theoretical results . . . . . 1589
M. Spieweck, M. Drescher, F. Gierschner, R. Irrgang, and U. Heinzmann

### Atomic and molecular processes in external fields

Self-calibrating method for measuring local multiphoton-ionization yields as a function of absolute intensity . . . . 1592
C. J. G. J. Uiterwaal, B. Witzel, H. Schröder, and K.-L. Kompa

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

Jump time in Landau-Zener tunneling . . . . . 1595
L. S. Schulman
Resonance fluorescence spectrum in a weak squeezed field with an arbitrary bandwidth . . . . . 1597
Z. Ficek, J. Seke, and R. Kralicek
Steady-state analysis of ac subharmonic generation in photorefractive sillenite crystals . . . . . 1601
Per M. Johansen, Henrik C. Pedersen, Evgeny V. Podivilov, and Boris I. Sturman
Demonstration of large amplification in multipulse-pumped lithiumlike aluminum soft-x-ray lasers . . . . . 1605
Tsuneyuki Ozaki and Hiroto Kuroda

## ERRATA

Erratum: Differential and integral cross sections for excitation of the electronic states of nitric oxide by low-energy electron impact: Observation of a $^2\Pi_r \rightarrow {}^2\Phi$ excitation process [Phys. Rev. A **54**, 2977 (1996)] . . . . . 1609
B. Mojarrabi, L. Campbell, P. J. O. Teubner, M. J. Brunger, and D. C. Cartwright
Erratum: Transition energy and lifetime for the ground-state hyperfine splitting of high-$Z$ lithiumlike ions [Phys. Rev. A **57**, 149 (1998)] . . . . . 1610
V. M. Shabaev, M. B. Shabaeva, I. I. Tupitsyn, V. A. Yerokhin, A. N. Artemyev, T. Kühl, M. Tomaselli, and O. M. Zherebtsov
Erratum: Quantum oscillator with fluctuating time-dependent frequency [Phys. Rev. A **57**, 2347 (1998)] . . . . . 1610
Loris Ferrari

*(Continued)*

**PHYSICAL REVIEW A** **THIRD SERIES, VOLUME 58, NUMBER 2** **AUGUST 1998**

Erratum: Laser spectroscopic studies of state-dependent collisional quenching of the lifetimes of metastable antiprotonic helium atoms [Physical Review A **57**, 1698 (1998)] . . . . . 1612
M. Hori, H. A. Torii, R. S. Hayano, T. Ishikawa, F. E. Maas, H. Tamura, B. Ketzer, F. J. Hartmann, R. Pohl, C. Maierl, M. Hasinoff, T. von Egidy, M. Kumakura, N. Morita, I. Sugai, D. Horváth, E. Widmann, J. Eades, and T. Yamazaki

**Cumulative Author Index** . . . . . 1628