REVIEWS of MODERN PHYSICS

Volume 81 **Number 1** **January–March 2009**

Author guidelines

1 ***Colloquium*: The physics of Maxwell's demon and information** — Koji Maruyama, Franco Nori, Vlatko Vedral

By encapsulating the essence of both thermodynamics and information Maxwell's demon provides valuable insights into very basic constraints on possible physical devices, both classical and quantum. This Colloquium explains various forms of the demon and presents numerous applications.

25 ***Colloquium*: Fundamentals of dust-plasma interactions** — P. K. Shukla, B. Eliasson

Mixtures of small particles (dust) with free electrons and ions (plasma) are found not only in low-temperature laboratory discharges but also in the near-Earth environment and interstellar space. This Colloquium describes the various dusty plasma environments, the forces acting therein, and the various structures that are found.

45 **Defects in correlated metals and superconductors** — H. Alloul, J. Bobroff, M. Gabay, P. J. Hirschfeld

In strongly correlated metals and superconductors, simple defects can have strong and surprising effects with important consequences for magnetism, transport, and collective phenomena such as superconductivity. In this review, an overview of the influence of controlled defects is provided, covering both theory and experiment, and systems from spin chains to high- T_c superconductors. A discussion regarding intrinsic defects is included.

109 **The electronic properties of graphene** — A. H. Castro Neto, F. Guinea, N. M. R. Peres, K. S. Novoselov, A. K. Geim

Theoretical treatments of graphene, the one-atom-thick allotrope of carbon, are reviewed and placed into context with respect to the most recent developments in this very active and rapidly evolving field. The topics discussed, which include the role of two-dimensional Dirac-like electronic excitations, the presence of unusual surface (edge) states, the consequences of disorder, elastic properties, bilayers and stacks, response to magnetic fields, and a treatment of complex many body effects, enable a comprehensive understanding of the promise of this unique two-dimensional material.

163 **Attosecond physics**

Ferenc Krausz
Misha Ivanov

Experimental tools and techniques for observing and steering electronic dynamics on the atomic scale are becoming available. Recent progress in attosecond physics has far reaching implications not only for physics but also biology and chemistry. This article addresses the key concepts and experimental tools which provide the means of observing and controlling the atomic-scale motion of electrons in real time, the theoretical models critical for connecting experimental observables with microscopic variables, and some expected implications of this revolution in technology.

235 **Nature of the 5*f* states in actinide metals**

Kevin T. Moore
Gerrit van der Laan

Actinide elements, including the technologically important elements U and Pu, show very interesting electronic properties that are due to the 5*f* electrons. This review gives an overview of this important field, and compares available experimental data with theoretical results obtained by atomic calculations, density-functional theory, and dynamical mean-field theory.

299 **Continuous-variable optical quantum-state tomography**

A. I. Lvovsky
M. G. Raymer

The goal of quantum tomography is to fully characterize the quantum state of a physical object. This is done by measuring different observables on identically prepared systems, and then reconstructing the state with the help of numerical algorithms out of the obtained data. This paper reviews different quantum-state tomographic methods for light fields. It includes those for the reconstruction of the quantum state of a single-mode optical field, as well as of the spatial mode for the case in which an optical field has a single photon. It also contains specific examples, as well as a variety of experimental results.

333 **Fractal structures in nonlinear dynamics**

Jacobo Aguirre
Ricardo L. Viana
Miguel A. F. Sanjuán

In both Hamiltonian and dissipative dynamical systems there exist fractal objects in phase space whose structure yields important information about the predictability of future evolution. This review provides a comprehensive overview of fractal basins in nonlinear dynamics, their calculation, classification, and experimental study.

387 **Artificial Brownian motors: Controlling transport on the nanoscale**

Peter Hänggi
Fabio Marchesoni

Brownian motion in systems with spatial or dynamic symmetry breaking, combined with external deterministic or random input signals, may assist directed motion of particles at submicrometer scales. For this phenomenon the term "Brownian motors" has been coined. There is a rich variety of possible Brownian motor scenarios and working principles in nature. The present review focuses on nonbiological, i.e., artificial, mostly solid state based Brownian motors and provides a comprehensive overview of the field, including newest developments in theoretical descriptions as well as most compelling experimental demonstrations and first successful technical applications.

443 **Erratum: *Colloquium*: Momentum of an electromagnetic wave in dielectric media [Rev. Mod. Phys. 79, 1197 (2007)]**

Robert N. C. Pfeifer
Timo A. Nieminen
Norman R. Heckenberg
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Forthcoming articles