

1127 Spin-polarized quantum confinement in nanostructures: Scanning tunneling microscopy

A full understanding of electron confinement at surfaces and in nanostructures requires that spin-polarization effects be taken into account. This review exploits energy-dependent and spatially resolved scanning tunneling microscopy and spectroscopy to elucidate the role of spin-polarized surface states, spin-dependent scattering by magnetic impurities, and the influence of such effects on the transport properties of nanostructures. Experimental results and theoretical insights converge to give a view of how spatial variations of the electron density impact magnetic properties when electrons are confined to structures with sizes comparable to the de Broglie wavelength.

Hirofumi Oka
Oleg O. Brovko
Marco Corbetta
Valeri S. Stepanyuk
Dirk Sander
Jürgen Kirschner

1169 Colloquium: Fractional calculus view of complexity: A tutorial

Fractional calculus used to belong to pure mathematics, but not any longer. With the increasing complexity found in systems with a large number of degrees of freedom, fractional calculus found its way into physical phenomena. This Colloquium reviews fractional calculus and its applications to fascinating problems in statistical physics, networks, and dissipative systems among others.

Bruce J. West

1187 Editorial: PRX Takes on a New Role

Gene D. Sprouse

1189 Colloquium: Emergent properties in plane view: Strong correlations at oxide interfaces

A key theoretical concept in condensed matter physics is the ability of a collection of interacting particles to exhibit new collective properties not found in individual particles. A key experimental development is the ability to fabricate atomic-precision multilayered structures whose component parts are transition metal oxides hosting strongly interacting electrons. This Colloquium brings these together, showing how strong correlations in combination with the access to new symmetries and electronic band structures provided by oxide interfaces can activate electronic properties not observable in bulk compounds.

Jak Chakhalian
John W. Freeland
Andrew J. Millis
Christos Panagopoulos
James M. Rondinelli

1203 Quantum channels and memory effects

A quantum channel is a communication link over which quantum particles can pass from end to end, arriving after more or less interaction and decoherence with the channel's environment. The capabilities of this channel are not simply an improved version of the classical channel, since the possibility of generating quantum entanglement from end to end leads to qualitatively different capabilities. This review presents the various concepts of quantum capacities that describe this information carrying capacity. The focus is on cases of channel environment with memory, when the interaction with quantum transmissions is influenced by past transmissions.

Filippo Caruso
Vittorio Giovannetti
Cosmo Lupo
Stefano Mancini

- 1261 *Colloquium: Quantum root-mean-square error and measurement uncertainty relations***
- Heisenberg's uncertainty principle is one of the pillars of quantum mechanics. In this Colloquium, issues arising with the use of the noise-operator concept for quantifying measurement errors are analyzed. An alternative way of adapting the classical concept of root-mean-square error to quantum measurements is presented, leading to Heisenberg-type measurement uncertainty relations.
- Paul Busch
Pekka Lahti
Reinhard F. Werner
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- 1283 *Hidden symmetries of dynamics in classical and quantum physics***
- Many physical systems display unexpected symmetries which are often discovered by careful analyses of their solutions and structures. These ubiquitous “hidden” symmetries are found in both classical and quantum systems. This review presents a detailed and instructive list of systems with hidden symmetries, including gravity. The prototypical examples of the Kepler problem and the Bohr atom are discussed and generalized in geometrical terms.
- Marco Cariglia
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- 1337 *Dielectric laser accelerators***
- The use of lasers to accelerate particles in dielectric structures has become much more prominent of late, with recent exciting results of electron acceleration in very short distances. The physics behind this involves the interaction of electrons with a laser field inside of complex photonic structures. This article reviews the physics of such accelerators. It discusses the multiple configurations that have been proposed, their fabrication methods, and experimental results to date. It also lists many of the possible applications for such compact accelerators.
- R. Joel England
Robert J. Noble
Karl Bane
David H. Dowell
Cho-Kuen Ng
James E. Spencer
Sami Tantawi
Ziran Wu
Robert L. Byer
Edgar Peralta
Ken Soong
Chia-Ming Chang
Behnam Montazeri
Stephen J. Wolf
Benjamin Cowan
Jay Dawson
Wei Gai
Peter Hommelhoff
Yen-Chieh Huang
Chunguang Jing
Christopher McGuinness
Robert B. Palmer
Brian Naranjo
James Rosenzweig
Gil Travish
Amit Mizrahi
Levi Schachter
Christopher Sears
Gregory R. Werner
Rodney B. Yoder

1391 Cavity optomechanics

The interplay between confined electromagnetic radiation and nanomechanical or micromechanical motion, often at the quantum limit, defines the subject of cavity optomechanics. This review covers the basics of optical cavities and mechanical resonators and their mutual optomechanical interaction mediated by forces resulting from radiation pressure. Currently many experimental systems provide realizations of cavity optomechanics. Perspectives for fundamental quantum physics and for possible applications of optomechanical devices are described.

Markus Aspelmeyer
Tobias J. Kippenberg
Florian Marquardt

1453 Erratum: Bose-Einstein condensation in quantum magnets [Rev. Mod. Phys. 86, 563 (2014)]

Vivien Zapf
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