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Announcement: Change in Printing Schedule to Synchronize Online and Print Products

Announcement: George Bertsch Retires
Achim Richter Assumes RMP Editorship

1083 Physics of thin-film ferroelectric oxides

M. Dawber
K. M. Rabe
J. F. Scott

The spontaneous alignment of electrical dipoles in a bulk solid—ferroelectricity—is a classical subject. Many uses of ferroelectrics such as for nonvolatile memory require thin films in which the interfaces play an important role, due to strain and other causes. Fortunately the length scales of *ab initio* computations have been growing, allowing great progress in the theoretical understanding of ferroelectrics with reduced dimensions. This review brings together the experimental, technological, and theoretical aspects of thin ferroelectric films.

1131 The interaction of relativistic particles with strong crystalline fields

Ulrik I. Uggerhøj

A relativistic particle channeled through a crystal is subjected to large coherent electromagnetic fields in its rest frame. At low and moderate energies the dynamics can be treated classically or semiclassically, but in the ultrarelativistic limit a full quantum electrodynamic theory is required. This article reviews the domains of the different theories with an emphasis on the experimental results, after briefly introducing the channeling phenomenon and its coherence properties.

1173 Isotope effects on the optical spectra of semiconductors

Manuel Cardona
M. L. W. Thewalt

Chemically and structurally "perfect" materials may not be isotopically pure, and this isotopic variation and disorder affects the physical properties through the vibrational mode spectrum and eigenvectors. This review begins by discussing the vibrational spectra, and then elaborates the effects of isotopic disorder on the electron-phonon interaction, made visible via the optical spectra. Over the years, the consequences have been particularly well studied in semiconductors, and a substantial part of the review covers work on diamond, Ge, and Si.

1225 **Quantum cloning**

Valerio Scarani
Sofyan Iblisdir
Nicolas Gisin
Antonio Acín

Classical information can be copied as many times as one wants. In the quantum world, however, some degradation is inevitable when one tries to copy the quantum state of a system into another one. This fundamental property of quantum physics is at the center of this article, which reviews copying methods from the point of view of minimizing the degradation. Possible applications might appear in quantum cryptography and light amplification.

1257 **The spin structure of the proton**

Steven D. Bass

The proton is a composite object, and its total spin is made from the spin of its constituents and their orbital angular momentum. Experimentally and contrary to all expectations, only a small fraction of the proton spin comes from spins of its quarks. This puzzle underlies the present review of the current theoretical understanding of the spin, as well as the experimental status and future prospects to see where it comes from.

1303 ***Colloquium*: Physically based fluid modeling of collisionally dominated low-temperature plasmas**

R. E. Robson
R. D. White
Z. Lj. Petrović

The modeling of low-temperature plasmas, which is important for describing processes underlying numerous applications, often employs *ad hoc* approximations that are not based on physical principles. The authors of this Colloquium address this situation by discussing the modeling of low-temperature plasma discharges and charged particle swarms from first principles, with all approximations and assumptions clearly spelled out. They also discuss benchmarks for checking consistency and accuracy.

1321 **Odd triplet superconductivity and related phenomena in superconductor-ferromagnet structures**

F. S. Bergeret
A. F. Volkov
K. B. Efetov

The singlet pairs in ordinary superconductivity can be converted to triplet pair correlations by contact with a ferromagnet. This article presents the needed theory to describe the effect and its physical consequences. Possible manifestations include enhanced Josephson currents and magnet penetration into the superconductor.

1375 **Nonlocal magnetization dynamics in ferromagnetic heterostructures**

Yaroslav Tserkovnyak
Arne Brataas
Gerrit E. W. Bauer
Bertrand I. Halperin

Heterostructures of ferromagnetic and normal metals allow one to produce macroscopic interactions between magnetization and electrical current. This review focuses on developments in this area in the last few years, especially the dynamics of two phenomena: spin-transfer torque, where a current may be used to orient the magnetic moment; and spin pumping, moving the ferromagnetic moment into the adjacent paramagnetic metal.

1423 **Effective-field theories for heavy quarkonium**

Nora Brambilla
Antonio Pineda
Joan Soto
Antonio Vairo

Quarkonium, the bound state of a heavy quark and antiquark, is a nonrelativistic system. The properties of such systems can be computed in a systematic way from QCD using effective field theory techniques. This article reviews the theoretical ideas, and their application to the spectroscopy, production, and decay of quarkonium states.

1497 **Forthcoming articles**

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