Reviews of Modern Physics

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323 **Instantons in QCD**

T. Schäfer
E. V. Shuryak

The dynamic properties of non-Abelian gauge theories such as quantum chromodynamics (QCD) are determined to a large extent by localized classical field configurations called instantons. In this article, the authors provide a pedagogical introduction to instantons and describe their role in quantum tunneling phenomena. They discuss the implications of instanton-dominated dynamics for light-hadron spectroscopy, the anticipated chiral phase transition at high temperatures, and other field theories such as supersymmetric QCD.

427 **Classical monoples: Newton, NUT-space, gravomagnetic lensing, and atomic spectra**

D. Lynden-Bell
M. Nouri-Zonoz

Gravomagnetic monopoles are the gravitational equivalent of magnetic monopoles. Remarkably enough, Newton described in a single sentence the essential features of the motion of a mass in the field of a gravomagnetic monopole. This paper discusses related problems with magnetic monopoles and presents the spectrum of monopolar hydrogen. The effect of gravomagnetic monopoles on general relativity is described, including gravitational lensing.

447 **Point scatterers for classical waves**

Pedro de Vries
David V. van Coevorden
Ad Lagendijk

Multiple scattering of electromagnetic waves plays an important role in the physics of a new class of optical systems including photonic bandgap materials, dense cold gases, and atomic lattices. The authors present a general, divergence-free, Green's-function formulation of the scattering of classical electromagnetic waves from resonant point scatterers. Several applications of the formalism are presented. For instance, the Lorentz-Lorenz relation for the dielectric constant in the long-wavelength limit is explicitly calculated for ordered and disordered dielectrics.

467 **Hamiltonian description of the ideal fluid** — P. J. Morrison

Fluid mechanical systems, including those that describe plasmas and other media, can be viewed as infinite-dimensional Hamiltonian systems. In the long history of fluid mechanics various state variables have been employed, and these different variables give rise to different Hamiltonian structures—unlike conventional field theories, the most commonly used variables are not canonical variables. The article briefly reviews low-degree-of-freedom Hamiltonian system lore, and then describes the different Hamiltonian structures for fluids and how Hamiltonian lore can be used to understand fluid dynamical properties such as stability.

523 **Coherent phonon polaritons as probes of anharmonic phonons in ferroelectrics** — H. J. Bakker, S. Hunsche, H. Kurz

Ferroelectrics are not only of high interest for optoelectric applications but they also serve as model systems for basic studies of phase transitions. The authors review the use of ultrashort laser pulses to investigate the terahertz response of these materials. The method allows the polariton dispersion relation to be measured to high accuracy and gives new information on the phonons related to the ferroelectric phase transition.

537 **Results from deuterium-tritium tokamak confinement experiments** — R. J. Hawryluk

For the first several decades of fusion plasma physics research, essentially all experiments were performed with ordinary hydrogen as the fuel. Only recently have plasmas been hot enough and sufficiently well confined to produce large amounts of fusion power, through operation with deuterium and tritium fuel. This article describes the first experiments yielding information on the physics of burning plasmas, including the behavior of alpha particles that are produced in the fusion reaction.

589 **Moon-Earth-Sun: The oldest three-body problem** — Martin C. Gutzwiller

The three-body problem, especially when in involves objects with large masses like the Moon, the Earth, and the Sun, has been a favorite topic of discussion for physicists, mathematicians, and astronomers for some 350 years. This article reviews the theoretical attention given to the problem both before and after Newton's discussion in his *Principia* in 1687. Although modern technology in connection with the space program has improved our ability to observe the system, our understanding of its dynamics is not as yet complete.

RMP Colloquia:

641 **The role of the Josephson-Anderson equation in superfluid helium** — Richard E. Packard

Two recent experiments on the quantum properties of vortices in superfluid helium are described and interpreted using a simple phase evolution equation.

653 **Renormalization group theory: Its basis and formulation in statistical physics** — Michael E. Fisher

Renormalization group theory is one of the most significant recent advances in theoretical physics owing to the universal behavior it predicts for physical systems near their critical points. Micheal E. Fisher, a major participant in the development of renormalization group theory, presents a personal perspective on the historical and conceptual origins of renormalization group theory and on its roots in the theory of critical phenomena.

683 **Forthcoming articles**

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