REVIEWS of MODERN PHYSICS

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421 **Foundations of nonlinear gyrokinetic theory**

A. J. Brizard
T. S. Hahm

This article surveys the foundations of modern nonlinear gyrokinetic theory. This theory is extremely important for understanding transport properties of magnetic confinement fusion devices and has much wider applications. It is important whenever strongly magnetized plasmas (ubiquitous in the Universe) contain turbulent electromagnetic fluctuations. This theory describes the complex plasma dynamics on time scales that are long compared to that of the gyromotion.

469 **Granular electronic systems**

I. S. Beloborodov
A. V. Lopatin
V. M. Vinokur
K. B. Efetov

This review deals with the theory of transport and thermodynamic properties of granular conductors focusing on systems made of metallic and superconducting granules imbedded in an insulating matrix. The authors present a comprehensive quantitative description of a very general class of disordered solids and show that granular conductors serve as an exemplary test ground for integrated theoretical-experimental studies of localization effects, metal- (superconductor-) insulator transitions, transport in disordered media, and other related phenomena central for contemporary condensed matter physics.

519 **Dissipation-induced instabilities in finite dimensions**

R. Krechetnikov
J. E. Marsden

Dissipation is usually thought of as a stabilizing effect. However, there are circumstances in which exactly the opposite happens: dissipation leads to destabilization. This article analyzes how and when this happens, bringing together various disparate threads in the literature. It presents many illustrative examples and identifies open problems requiring further study.

555 **Reference frames, superselection rules, and quantum information**

Stephen D. Bartlett
Terry Rudolph
Robert W. Spekkens

How can two parties communicate quantum information if they do not share a common reference frame? This question underlines an important issue in quantum communication, as well as in the problems of clock synchronization and Cartesian axes alignment. This paper contains the answer to this and other questions related to reference frames and to superselection rules in quantum information processing.

611 **Statistical topology of closed curves: Some applications in polymer physics** — E. Orlandini, S. G. Whittington

Random walks play a central role in many aspects of physics, from diffusion and heat flow to the dynamics of spins. Random walks which are constrained to be non-self-intersecting are a useful model for the configurational properties of linear polymer molecules in dilute solution. In this article, the authors discuss the statistics of closed self-avoiding random walks, with a special emphasis on their topological properties. The statistics of knot type, crossing number, and other geometric quantities are reviewed in the context of numerical experiments, analytical calculations, and rigorous results. The necessary language of knot theory and topology is concisely reviewed and related to questions in polymer physics.

643 **Stress focusing in elastic sheets** — T. A. Witten

Bending a surface without tearing it involves a subtle interplay between the geometry of the surface and its in-plane elasticity. When the surface cannot stretch, curvature singularities occur under an external load, sometimes at points and sometimes along lines. The crumpled zones form the basis to understanding these highly nonlinear phenomena in terms of stress focusing and extreme geometry. This article reviews the state of the art in the theory of inextensible surfaces under structureless forces.

677 **Electronic and transport properties of nanotubes** — Jean-Christophe Charlier, Xavier Blase, Stephan Roche

Carbon nanotubes are of great fundamental and applied interest, given their unusual electronic properties linked to their specific topology. This article reviews the electronic structure and transport properties in these systems 1D systems, including localization effects due to defects and the Aharonov-Bohm effect.

733 **Flux compactification** — Michael R. Douglas, Shamit Kachru

One of the most significant developments in string theory in recent years has been the discovery that compactifications with flux cast many important issues in a new light. They can stabilize solutions and eliminate unwanted massless scalar fields (called moduli). They warp the geometry, which provides a possible solution of the hierarchy problem. They can account for supersymmetry breaking and the cosmological constant. They suggest new scenarios for early Universe cosmology such as "brane inflation." They give an enormous "landscape" of possible solutions, which suggests new strategies for making contact with the real world. All this is surveyed in this review written by two of the leading experts in the field.

797 **Publisher's Note: Linear optical quantum computing with photonic qubits [Rev. Mod. Phys. 79, 135 (2007)]** — Pieter Kok, W. J. Munro, Kae Nemoto, T. C. Ralph, Jonathan P. Dowling, G. J. Milburn

Forthcoming articles