Reviews of Modern Physics

Volume 71 **Number 4** **July 1999**

863 **Nobel Lecture: Fractional quantization** — R. B. Laughlin

875 **Nobel Lecture: The fractional quantum Hall effect** — Horst L. Stormer

891 **Nobel Lecture: Interplay of disorder and interaction in two-dimensional electron gas in intense magnetic fields** — Daniel C. Tsui

The 1998 Nobel Prize in Physics was shared by R. B. Laughlin, Horst L. Stormer, and Daniel C. Tsui. These papers are the texts of their addresses on the occasion of the award.

897 **Gamma-ray astronomy at high energies** — C. M. Hoffman, C. Sinnis, P. Fleury, M. Punch

Observations of astronomical gamma rays in the 1990s revealed a rich structure in the high-energy universe. This article surveys the present status of the field, discussing the detectors, the findings, and the current interpretations. Highlights are the many new sources seen by the Compton Gamma Ray Observatory and the discovery of TeV gamma rays from extragalactic point sources by ground-based air Čerenkov detectors.

937 **Searches for supersymmetric particles at the Tevatron collider** — M. Carena, R. Culbertson, H. Frisch, S. Eno, S. Mrenna

The known elementary particles would have heavy partners according to supersymmetric theories, and the quest to find them is an important objective of Fermilab's proton-antiproton collider, the Tevatron. This article describes the signature to detect supersymmetric particles, the constraints imposed by existing data, and the prospects of observing them in the forthcoming experiments at the upgraded Tevatron.

983 **Brane dynamics and gauge theory** — Amit Giveon, David Kutasov

String theory contains extended objects known as branes, whose worldvolume dynamics reduces at low energies to different field theories. Brane dynamics provides an efficient tool for analyzing the corresponding field theories. Many phenomena that are mysterious

in field theory have a simple geometric interpretation in the brane picture. Conversely, known features of gauge theories lead to new insights on the dynamics of branes in string theory. This review provides a comprehensive survey of the interplay between brane dynamics in string theory and gauge theories in various dimensions.

1085 **Linear scaling electronic structure methods** — Stefan Goedecker

Recently there has been great interest in ''Order-N'' electronic structure calculational methods that only require a computation effort that increases linearly with the size of the system. These approaches are based on algorithms that take advantage of the decay of the quantum-mechanical density matrix. This article examines the algorithms that have been developed, discusses the various cases that arise physically, and describes some typical applications.

1125 **Spontaneous ordering of nanostructures on crystal surfaces** — Vitaliy A. Shchukin, Dieter Bimberg

This review addresses the theoretical concepts and experiential results concerning spontaneous formation of periodically ordered structures on crystal surfaces. Faceted surfaces, planar domains, and three-dimensional coherently strained islands are treated as equilibrium structures of elastic domains. The theory is applied to the problem of fabricating ordered arrays of semiconductor quantum dots.

1173 **Physics of reaction waves** — A. G. Merzhanov, E. N. Rumanov

Reaction waves, in which an energy source sustains a wave front, occur in many areas of physics. This article reviews the mathematical theory of these waves as formulated by Zel'dovich and others. Complex behavior, including spirals and periodic waves, are seen to evolve from simple interface dynamics.

RMP Colloquia:

1213 **Solar neutrino experiments: results and implications** — Till A. Kirsten

Results of five different solar neutrino experiments are presented and analyzed. This evidence is convincing that solar neutrino oscillations occur, implying indirectly a nonzero neutrino mass. The future outlook for further solar neutrino experiments is also surveyed.

1233 **The ''friction'' of vacuum, and other fluctuation-induced forces** — Mehran Kardar, Ramin Golestanian

The authors demonstrate the unity and simplicity underlying various examples of fluctuation-induced phenomena arising from quantum fluctuations of the electromagnetic field, from thermal fluctuations of a correlated fluid, or from fluctuations of ions in solution. Examples are given for diverse contexts ranging from biophysics to cavity QED.

1247 **Erratum: Gravitational radiation [Rev. Mod. Phys. 71, S187 (1999)]** Rainer Weiss

1249 **Erratum: High-transition-temperature superconducting quantum interference devices [Rev. Mod. Phys. 71, 631 (1999)]** D. Koelle, R. Kleiner, F. Ludwig, E. Dantsker, John Clarke

1251 **Forthcoming articles**