Reviews of Modern Physics

Volume 73 **Number 1** **January 2001**

Author guidelines

1 ***Colloquium*: Criticality and superfluidity in liquid ^{4}He under nonequilibrium conditions** — Peter B. Weichman, Alexa W. Harter, David L. Goodstein

The transition between normal conductive and superfluid hydrodynamic modes of heat transport in liquid He-4 is analyzed here theoretically as a critical transition under nonequilibrium conditions. Gravity is shown to play an important role. The analysis has application to planned experiments in space, where the microgravity environment greatly increases the sharpness of the critical singularities, and hence allows experimental measurements to probe much more deeply into the asymptotic critical region.

17 ***Colloquium*: Femtosecond x-ray crystallography** — Antoine Rousse, Christian Rischel, Jean-Claude Gauthier

X-ray diffraction experiments with resolutions down to 10^{-13} sec offer the promise of observing transition processes while they happen. This Colloquium surveys the different kinds of experiments providing such resolution, the various sources of intense x rays, and the current experimental constraints on the processes that may be studied. It then describes some of the first experimental results on condensed-matter systems.

33 **Quantum Monte Carlo simulations of solids** — W. M. C. Foulkes, L. Mitas, R. J. Needs, G. Rajagopal

Of the computational techniques available for the electronic structure of large systems, the stochastic quantum Monte Carlo method offers the most systematic approach for treating correlations. The authors describe techniques based on trial wave functions and show their applicability to a variety of problems in solids.

85 **Observation of atmospheric neutrinos** — Takaaki Kajita, Yoji Totsuka

Compelling evidence for neutrino oscillation, recently obtained through observations of atmospheric neutrinos in Super-Kamiokande and other large underground neutrino detectors, has had a major impact on particle physics. After a brief survey of historical and theoretical aspects, this review considers the wide range

of experimental data and analyses in the context of neutrino oscillations. Atmospheric neutrino experiments are now moving from the discovery phase into the precision measurement phase.

119 **Aspects of chiral symmetry and the lattice** — Michael Creutz

One of the interesting challenges in the standard theory of particle physics is to reconcile seemingly contradictory symmetry requirements. This is particularly true of lattice formulations of QCD and chiral symmetry. This article explores the conceptual background of the chiral symmetry problem and discusses some of the recent progress towards dealing with it.

151 **Muon decay and physics beyond the standard model** — Yoshitaka Kuno, Yasuhiro Okada

Recently, lepton-flavor-violating (LFV) rare muon processes such as $\mu^+ \to e^+ \gamma$ decay or $\mu^- - e^-$ conversion have attracted particular attention because of their potential to search for physics beyond the standard model. Many supersymmetric models predict sizable lepton flavor violation. The authors review the current theoretical and experimental status of rare muon decay and describe future prospects in this field.

203 **Resonant inelastic x-ray scattering spectra for electrons in solids** — Akio Kotani, Shik Shin

X-ray spectroscopy has made remarkable progress with the availability of high-brilliance synchrotron sources. A powerful new tool for electronic structure studies is resonant inelastic x-ray scattering, a coherent process similar to Raman scattering in which the incident x ray scatters inelastically, creating electronic excitations. The spectra provide information about the electronic density of states in weakly correlated systems and about local interactions in strongly correlated systems such as rare earths and transition-metal oxides.

247 **Erratum: Energetics of Si(001)** [**Rev. Mod. Phys. 72, 593 (2000)**] — H. J. W. Zandvliet

249 **Forthcoming articles**