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Author guidelines

1 ***Colloquium*: Opportunities in nanomagnetism** — S. D. Bader

In this Colloquium the challenges, prospects, and applications of nanotechnology are surveyed within the context of nanomagnetism, the science of magnetic materials, and devices on the nanoscale. Spin transport, magnetic vortices, spring magnets, and magnetic viruses are specific examples that are used to illustrate general principles of nanofabrication as well as novel spin phenomena exhibited by these nanostructures.

17 **Doping a Mott insulator: Physics of high-temperature superconductivity** — Patrick A. Lee, Naoto Nagaosa, Xiao-Gang Wen

One of the paths on the odyssey to a theory of high-temperature superconductivity is the "resonating valence bond" idea proposed by Anderson. This review discusses relevant experimental phenomenology and follows the mathematical developments of the idea, progressing from the mean-field theory of the *t-J* model and leading to strong-coupling gauge theories.

87 **Onsager and the theory of hydrodynamic turbulence** — Gregory L. Eyink, Katepalli R. Sreenivasan

Besides Onsager's well-known contributions to physics and chemistry, he had a life-long interest and made ground-breaking discoveries in the subject of hydrodynamic turbulence. His 1949 paper stimulated considerable later work, but it is in his private letters and unpublished notes that some of the most original ideas appeared. In at least four cases, the theories were developed and published only decades later by others.

137 ***Colloquium*: Nonlinear energy localization and its manipulation in micromechanical oscillator arrays** — M. Sato, B. E. Hubbard, A. J. Sievers

Intrinsic localized modes (ILMs) are localized energy states that can appear anywhere in nonlinear periodic discrete lattices and can propagate. In contrast to solitons in continuous nonlinear media, the dynamics of ILMs is much richer, permitting, for example, inelastic scattering. This Colloquium describes recent experiments studying the behavior of these localized energy modes in silicon-based mi-

cromechanical arrays, using optical imaging and laser manipulation techniques.

159 ***Colloquium*: Scaled particle theory and the length scales of hydrophobicity** — Henry S. Ashbaugh, Lawrence R. Pratt

Understanding how the physical properties of atoms and molecules in aqueous solutions vary with temperature is a key step toward elucidating the functional behaviors of biophysical molecular structures. In this Colloquium, the authors describe a "scaled particle theory" of molecules in solution that pinpoints a molecular length at which microscopic and macroscopic descriptions of the molecular species can be joined. The theory successfully describes the temperature variations of key thermodynamic variables.

179 **Dynamics of Bose-Einstein condensates in optical lattices** — Oliver Morsch, Markus Oberthaler

Cold atoms stored in optical lattices display a great variety of quantum phenomena, similar to those found in certain solid-state systems. However, by using external fields the atoms can be brought to new experimental regimes and thus allow one to explore novel phenomena. This article contains a theoretical description of such a system, as well as the results of the most recent experiments in this area.

217 **Opportunities for mesoscopics in thermometry and refrigeration: Physics and applications** — Francesco Giazotto, Tero T. Heikkilä, Arttu Luukanen, Alexander M. Savin, Jukka P. Pekola

This review describes unique thermal properties of mesoscopic structures with sizes between atomic and macroscopic scales, and how they can be applied to thermometry, refrigeration, and thermal detection. The emphasis is on low temperatures where physical phenomena on mesoscopic length scales in conjunction with hybrid combinations of superconductors, insulators, normal metals, and doped semiconductors create opportunities for a rich variety of novel device concepts.

275 **The kernel polynomial method** — Alexander Weiße, Gerhard Wellein, Andreas Alvermann, Holger Fehske

A common problem in computational physics is the calculation of linear response functions which depend on the spectral properties of large-dimensional Hamiltonian matrices. Among the methods employed, expansions based on Chebyshev polynomials are particularly efficient. This review explains how such polynomial expansions work, shows which quantities are accessible, and compares this approach to other numerical techniques.

307 **Forthcoming articles**