

REVIEWS of MODERN PHYSICS

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021001 *Colloquium: Strongly interacting photons in one-dimensional continuum*

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Photons, the particles of light, are in most conditions very weakly interacting. Nevertheless, it is possible to make them interact by altering environmental conditions, for instance, in the interior of certain materials or by squeezing them in confined geometries. In this Colloquium the topic of photons strongly interacting when confined to a one-dimensional geometry is discussed from experimental and theoretical perspectives.

025001 *Testing black hole candidates with electromagnetic radiation*

Cosimo Bambi

Can one determine the black hole nature of an observed object by electromagnetic observations? As astrophysical black holes are expected to result from collapse with nonzero angular momentum, the spacetime geometry would correspond to the Kerr metric. This review discusses how electromagnetic radiation emitted by gas or stars orbiting these objects can potentially be utilized to test the Kerr black hole hypothesis with current and future observational facilities.

025002 *Experimental soft-matter science*

Sidney R. Nagel

Soft condensed matter refers to materials where the constituent building blocks are larger than atoms but smaller than the system itself. The large size of the constituent particles makes these soft materials distinctive from hard condensed matter systems. Soft matter is easily deformable, dissipative, disordered, nonlinear, far from equilibrium, thermal and entropic, slow, observable, susceptible to external fields, patterned, nonlocal, interfacial elastic, memory retaining, and active. This article surveys soft-matter science and discusses different classes of systems including colloids; emulsions; foams; glassy, granular, and jammed matter; liquid crystals; polymers; adaptive mechanical metamaterials; and active matter.

025003 *Quantum spin liquid states*

Yi Zhou
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The concept of a quantum spin liquid is important for problems ranging from quantum spin chains to high-temperature superconductivity. This review gives a pedagogical introduction to the theoretical concepts behind this fascinating topic and also discusses the current experimental situation.

025004 Graviton mass bounds

If gravitation propagates via a massive field, the velocity of gravitational waves (gravitons) depends on their frequency. Gravitational waves emitted early during the inspiral of compact binaries would travel slower than those emitted later, causing an offset in relative arrival times. This review utilizes the first direct detections of gravitons from two inspiraling black holes for setting an upper mass bound, examines it within the framework of massive gravity theories, and compares to observational bounds obtained from other related effects.

Claudia de Rham
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025005 Quantum Hall physics: Hierarchies and conformal field theory techniques

The quantum Hall effects by now are recognized as prime examples of the importance of topological considerations in condensed matter physics. The fractional quantum Hall effect in particular has proven to display a large number of topologically ordered states that have been classified and understood in terms of hierarchical schemes. This review explains the current understanding of such classifications, with particular emphasis on conformal field theory approaches.

T. H. Hansson
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025006 Interface-induced phenomena in magnetism

Magnetism at interfaces often takes on a fundamentally completely different character when compared to magnetism in bulk. This review focuses on these differences and provides an overview of magnetic interfaces relevant to modern spintronics beginning from the most basic and well-understood questions and reaching to the frontiers of knowledge. Topics covered include interfacial spin-orbit coupling, spin-transfer torques, interface-induced exotic spin textures, interface-dependent magnetization dynamics, and the interplay between charge, spin, orbital, and lattice degrees of freedom. This review provides perspectives in key areas and poses questions that may inspire unanticipated control strategies for magnetic interfaces for future magnetic recording and memory applications.

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025007 Frontiers of chaotic advection

The physics of chaotic advection is a field that emerged at the intersection of nonlinear dynamics and fluid mechanics. An older term for the field is Lagrangian turbulence. This review deals with mathematical physics descriptions and perspectives of chaotic features in transport and mixing in fluid systems of sizes ranging from micrometers to hundreds of kilometers.

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025008 Perpendicular magnetic anisotropy at transition metal/oxide interfaces and applications

In spintronics devices, magnetic materials are used as polarizers or analyzers for electron spin. Magnetic anisotropy defines the orientation for magnetization and polarization of spin currents traversing the material. This review focuses on perpendicular magnetic anisotropy which arises at magnetic metal/oxide interfaces. This anisotropy plays a role in the magnetic memory based on magnetic tunnel junctions. Aspects of the anisotropy are described in various applications and in the field of spintronics research.

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029901 Erratum: Carrier dynamics in semiconductors studied with time-resolved terahertz spectroscopy [Rev. Mod. Phys. 83, 543 (2011)]

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