Reports on Progress in Physics

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KEY ISSUES REVIEW

022001 Hamiltonian complexity
Tobias J Osborne

Summary: Recent years have seen the birth of a new field known as Hamiltonian complexity lying at the crossroads between computer science and theoretical physics. Hamiltonian complexity is directly concerned with the question: how hard is it to simulate a physical system? This article reviews the foundational results, guiding problems and future directions of this emergent field.

REPORTS ON PROGRESS

024401 Experimental quantum simulations of many-body physics with trapped ions
Ch Schneider, Diego Porras and Tobias Schätz

Summary: One can gain deeper insight into complex quantum dynamics by experimentally simulating the quantum behaviour of interest in another quantum system (where the relevant parameters and interactions can be controlled and robust effects detected sufficiently well). Systems of trapped ions provide unique control of both the internal (electronic) and external (motional) degrees of freedom. The mutual Coulomb interaction between the ions allows for large interaction strengths at comparatively large mutual ion distances enabling individual control and readout. This article provides an overview of different trapping techniques of ions as well as implementations for coherent manipulation of their quantum states and discusses the related theoretical basics. Experimental and theoretical progress in simulating quantum many-body physics with trapped ions, and present current approaches for scaling up to more ions and more-dimensional systems are also discussed.

024402 Nanooantennas for visible and infrared radiation
Paolo Biasiotti, Jie-Shing Huang and Bert Hecht

Summary: Nanooantennas for visible and infrared radiation can strongly enhance the interaction of light with nanoscale matter by their ability to efficiently link propagating and spatially localized optical fields. This ability unlocks an enormous potential for applications ranging from nanoscale optical microscopy and spectroscopy over solar energy conversion, integrated optical nanocircuitry, opto-electronics and density-of-states engineering to ultra-sensing as well as enhancement of optical nonlinearities. This article reviews the current understanding of metallic optical antennas based on the background of both well-developed radio wave antenna engineering and the emerging field of plasmonics. Particular focus is placed on the role of plasmonic resonances on the performance of nanooantennas, and the influence of geometrical parameters imposed by nanofabrication. A brief account of the current status of the field and the major established and emerging lines of investigation in this vivid area of research is also given.

REVIEW ARTICLES

026301 Properties of the nuclear medium
M Baldo and G F Burgio

Summary: This article reviews our understanding of the properties of the nuclear medium that have been studied, for many years, on the basis of many-body theory, laboratory experiments and astrophysical observations. Particular emphasis is placed on the possible relationship and links between the nuclear medium and the structure of nuclei, including the limitations of such an approach.

026302 MUSE, the goddess of muons, and her future
Ryosuke Kudono and Yasuhiro Miyake

Summary: The Muon Science Establishment (MUSE) is one of the major experimental facilities along with those for neutron, hadron, and neutrino experiments in J-PARC. Its beamline has the world’s highest muon intensity (∼ 10^6 μ^-1 s^-1) at a proton beam power of 120 kW. This article reviews the present performance of (Continued on inside back cover)

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