

REVIEWS of MODERN PHYSICS

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031001 *Colloquium:* Toward living matter with colloidal particles

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Vinothan N. Manoharan
Michael P. Brenner

Living systems are undoubtedly complicated. The complicated behaviors result from interactions between many different components. In this Colloquium colloidal systems are shown to exhibit lifelike behavior such as spontaneous assembly of complex structures, the ability to self-replicate, and the ability to perform complex and coordinated metaboliclike behavior. This behavior arises from programming of the interactions between components of the colloidal system.

035001 Strongly coupled quark-gluon plasma in heavy ion collisions

Edward Shuryak

The field of relativistic heavy ion collisions spans over five decades ranging from the formulation of scientific goals and early experiments at Berkeley in the 1960s with mostly lighter heavy ions via the start of operation of the Relativistic Heavy Ion Collider (RHIC) at Brookhaven in the year 2000 up to the Large Hadron Collider (LHC) at CERN, where the first experiments took place in 2010. The data from the RHIC and LHC experiments and their theoretical explanations outlined in this review provide convincing evidence for the creation of a strongly coupled quark-gluon plasma, i.e., a nearly perfect fluid with large entropy density to viscosity ratio formed during collision.

035002 Quantum sensing

C. L. Degen
F. Reinhard
P. Cappellaro

Quantum technologies are increasingly driving the field of precision metrology. While current techniques for sensing and recording time rely on classical devices, quantum sensors exploit quantum systems to reach unprecedented levels of precision. The working part of the sensor contains one or a few qubits, and resources like quantum entanglement are chosen and tailored to maximize sensitivity. This review introduces quantum sensing from the perspective of working experimentalists, with specific sensor implementations, concepts and methods, and recent developments.

035003 Simulation and understanding of atomic and molecular quantum crystals

Claudio Cazorla
Jordi Boronat

Solids formed by light atoms or molecules have, at experimentally realizable low temperatures, a kinetic energy per particle that is large compared to the thermal energy. Examples include solid helium, hydrogen, and methane, which are important in a variety of contexts. This review provides an introduction to these “quantum crystals,” with a focus on simulation techniques suitable for describing and understanding them.

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| 035004 | Electron vortices: Beams with orbital angular momentum | S. M. Lloyd
M. Babiker
G. Thirunavukkarasu
J. Yuan |
| <p>This article presents a review on electron vortex beams highlighting both their experimental and theoretical aspects. The unique characteristics of electron vortex states as well as their similarities with orbital angular momentum states of light are discussed and perspectives are offered for their application in a number of technologies.</p> | | |
| 035005 | Yield stress materials in soft condensed matter | Daniel Bonn
Morton M. Denn
Ludovic Berthier
Thibaut Divoux
Sébastien Manneville |
| <p>This review discusses disordered materials that only flow if the imposed stress is beyond a certain threshold value. These so-called yield stress materials cannot be described as elastic solids nor as simple Newtonian fluids. Examples include whipped cream, toothpaste, cement, ketchup, and mayonnaise. The physical origin of the yield stress, the nonlinear flow behavior, and experimental techniques to investigate these materials are discussed. Also an overview of the microscopic theoretical descriptions of the nonlinear flow dynamics is presented.</p> | | |
| 035006 | Universal few-body physics and cluster formation | Chris H. Greene
P. Giannakeas
J. Pérez-Ríos |
| <p>A comprehensive account of the theoretical analyses of the Efimov effect and the universal properties of three-body bound states is provided. Recent experimental studies are reviewed and showed how the few-body analysis also yields insights into many-body phenomena, accessible by the experimental ability to tune the range and strength of the forces between cold atoms.</p> | | |
| 035007 | The $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction and its implications for stellar helium burning | R. J. deBoer
J. Görres
M. Wiescher
R. E. Azuma
A. Best
C. R. Brune
C. E. Fields
S. Jones
M. Pignatari
D. Sayre
K. Smith
F. X. Timmes
E. Uberseder |
| <p>The $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction is essential for the production of carbon and oxygen in the Universe and also for the composition of stellar cores after helium burning, a key determinant for supernova explosions. This review summarizes the current experimental understanding, theoretical underpinning, and the interpretation of reaction data for this critical reaction. It is shown that the desired level of uncertainty, $\approx 10\%$, may be in sight, but several inconsistencies need to be overcome. Ways to move forward beyond the state of the art are discussed.</p> | | |
| 035008 | Multiboson interactions at the LHC | D. R. Green
P. Meade
M.-A. Pleier |
| <p>At the LHC the production of two or more gauge bosons is completely predicted by the standard model to high precision. Departures from those predictions are very sensitive probes of new physics. This article reviews the theoretical framework for probing such non-standard-model effects and summarizes the results from LHC operation at 7 and 8 TeV.</p> | | |