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Colloquium: What do we mean by 'active matter'?

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Rev. Mod. Phys. **98**, 031001 (2026) - Published 13 July, 2026

Active matter has become a lively topic in recent years, but what exactly is meant by the term 'active matter' is often unclear. This Colloquium discusses the scientific and semantic issues underlying this ambiguity, as well as the history of the field, and offers a definition of active matter as a well-defined subset of nonequilibrium systems. It then surveys recent developments including nonreciprocal interactions, intracellular phase separation, and quantum active matter.

Colloquium: Strongly dipolar molecular Bose-Einstein condensates: From few- to many-body physics

Andreas Schindewolf, Jens Hertkorn, Ian Stevenson, Matteo Ciardi, Phillip Groß, Dajun Wang, Tijs Karman, Goulven Quéméner, Sebastian Will, Thomas Pohl, and Tim Langen

Rev. Mod. Phys. **98**, 031002 (2026) - Published 20 August, 2026

Recent advances in molecular cooling have enabled the realization of strongly dipolar molecular Bose-Einstein condensates. Such systems provide a unique platform for investigating new states of matter, from quantum droplets to supersolids. This Colloquium surveys the collisional shielding techniques that make stable molecular condensates possible, the theoretical challenges that arise in the strongly dipolar regime, and the exotic quantum phases now within experimental reach.

Colloquium: Manabe's legacy of simulating and understanding global warming

T. A. Shaw

Rev. Mod. Phys. **98**, 031003 (2026) - Published 28 September, 2026

Syukuro "Suki" Manabe won part of the 2021 Nobel Prize in Physics for his role in predicting global warming using early climate models. This Colloquium traces that decades-long effort, showing how Manabe combined bedrock physical laws with a keen intuition for simplifying assumptions to construct a hierarchy of climate models, ranging from a simple 1D model of the globally averaged atmosphere to a 3D model of the fully coupled atmosphere-ocean system with realistic continental geometry. Each rung of this hierarchy yielded new insight and specific predictions, not just for global warming but also for the spatial patterns of warming—predictions borne out by subsequent observations.

Colloquium: Laboratory exploration of planetary interiors

G. W. Collins, S. Seager, J. Eggert, X. Gong, M. Huff, J. R. Rygg, T.-A. Suer, and R. Jeanloz

Rev. Mod. Phys. **98**, 031004 (2026) - Published 30 September, 2026

Astronomers observe thousands of planets beyond our Solar System, many with extreme interior conditions. Deep inside these worlds, gravity produces pressures millions to billions of times stronger than Earth's atmosphere. At these pressures, matter behaves in surprising ways: hydrogen can become metallic, water and ammonia may form exotic superionic states, and hydrocarbons can turn into diamond. This Colloquium describes how studying these unusual materials helps scientists explain how planets form, evolve, and generate magnetic fields and magma oceans. Using powerful lasers and pulsed-power facilities, researchers recreate such pressures in laboratories, revealing new physics and improving understanding of the hidden interiors of distant planets.

Ion Coulomb crystals: An exotic form of condensed matter

Giovanna Morigi, John Bollinger, Michael Drewsen, Daniel Podolsky, and Efrat Shimshoni

Rev. Mod. Phys. **98**, 035001 (2026) - Published 5 August, 2026

Coulomb crystals form when the Coulomb interaction between charged particles dominates over kinetic energy; the prototype is the Wigner crystal formed by conduction electrons in metals at low densities. In recent years, it has become possible to realize Coulomb crystals using laser-cooled trapped ions, and these systems allow for unprecedented control of experimental parameters. This review describes the state of the art of ion Coulomb crystals in one, two, and three dimensions, their properties in and out of equilibrium, and their importance across fields ranging from condensed matter to astrophysics.

Polarons in atomic gases and two-dimensional semiconductors

Pietro Massignan, Richard Schmidt, Grigori E. Astrakharchik, Ataç İmamoğlu, Martin Zwierlein, Jan J. Arlt, and Georg M. Bruun

Rev. Mod. Phys. **98**, 035002 (2026) - Published 2 September, 2026

The polaron, a single impurity embedded in a quantum many-body environment, conceptually bridges few- and many-body physics. Its properties provide both a test bed for many-body theories and physical insight into the phase structure of more complicated many-body systems. This review discusses two pristine experimental platforms in which polarons have recently been realized: ultracold atomic gases and atomically thin transition-metal dichalcogenides. The authors discuss the theory of Bose and Fermi polarons, compare theory to experiment, and provide a perspective on how polarons may serve as precise sensors in complex environments.

Security proofs for practical QKD: Variations, techniques, gaps, and limitations

Devashish Tupkary, Ernest Y.-Z. Tan, Shlok Nahar, Lars Kamin, and Norbert Lütkenhaus

Rev. Mod. Phys. **98**, 035003 (2026) - Published 8 September, 2026

It is sometimes said that if one uses quantum cryptography methods to distribute keys, their secrecy is guaranteed by the laws of physics. This is only partly true: while quantum physics provides a strong boost to security, the proper mathematical analysis of the full detailed protocol is still nontrivial. This review provides details of this analysis for one of the most important quantum protocols for key distribution and its variants, in which weak (few photon) coherent pulses are transmitted and threshold detectors are used for measurements.

Opinion dynamics: Statistical physics and beyond

Michele Starnini, Fabian Baumann, Tobias Galla, David Garcia, Gerardo Iñiguez, Márton Karsai, Jan Lorenz, and Katarzyna Sznajd-Weron

Rev. Mod. Phys. **98**, 035004 (2026) - Published 10 September, 2026

Social systems, when considered on an appropriately coarse-grained scale, display phenomena reminiscent of the behavior of physical many-body systems and can be studied using the methods of statistical mechanics. A particularly interesting subfield is opinion dynamics, which aims to understand the emergence of collective social phenomena, such as consensus, polarization, and fragmentation. This review systematizes the terminology and methods of opinion dynamics, surveys empirical findings alongside theoretical models, and summarizes the current state and future directions of this field.

Quantum geometry phenomena in condensed matter systems

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Rev. Mod. Phys. **98**, 035005 (2026) - Published 22 September, 2026

The observation by Berry that adiabatic transport around a closed loop leads to a phase in addition to that determined by the energy spectrum lies at the heart of topology in solids. Such geometrical effects have measurable physical consequences, notably quantum Hall physics in the absence of an external magnetic field—all of which are encapsulated by the quantum geometric tensor. The imaginary part of this tensor is the Berry curvature, and the real part encodes the distance between nearby wave functions and hence is referred to as the quantum metric. In recent years, the quantum geometric tensor has proven central to novel many-body effects in quantum matter, including superconductivity in flat-band systems, third-order nonlinear Hall effects, and second-harmonic nonlinear Hall effects, to name a few. This review catalogs these advances with an eye toward showing how new many-body effects arise from quantum geometry.

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