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025001 **Programmable quantum simulations of spin systems with trapped ions**

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Trapped ions have always been among the leading contenders for the realization of a quantum computer. This review reports on progress in the use of these current-day quantum machines for the simulation of hard problems in spin dynamics of one-dimensional chain systems. Considerable acrobatics are needed to hide the real ion-spectroscopy physics and transform it into the quantum dynamics of the condensed matter system; this quantum computer is equally capable of simulating equilibrium spin physics and nonequilibrium dynamics. Prospects for scaling beyond 100 qubits are real, and the exploration of topological phases is on the horizon.

025002 **Experimental perspective on three-dimensional topological semimetals**

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A confluence of precise theoretical predictions shows that carefully fabricated three-dimensional (3D) semimetals can host a variety of exotic phases dominated by topological constraints. This experimental review of 3D topological semimetals addresses the role that electronic structure and associated band crossings play in validating Dirac and Weyl fermion descriptions that have analogies with elementary particles in quantum field theory. The importance of Fermi arcs, nodal geometries, symmetry, spin-orbit coupling, and dimensionality is highlighted. A list of confirmed 3D topological semimetals is presented with suggestions for future research and applications.

025003 **Finite-temperature transport in one-dimensional quantum lattice models**

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One-dimensional models of interacting electrons have long served as a testing ground for theoretical and numerical methods. More recently they have become directly relevant for interpreting experiments on spin chains, and ultracold quantum gases. This review gives an overview of progress in this important field, with an emphasis on transport properties at nonzero temperatures, covering both theoretical and numerical approaches.

025004 **Emergent constraints on climate sensitivities**

Mark S. Williamson, Chad W. Thackeray, Peter M. Cox, Alex Hall, Chris Huntingford, Femke J. M. M. Nijsse

Emergent constraints (ECs) relate observables of the climate system to equivalent quantities simulated from Earth system models that are related to properties of the future climate. The uncertainties in projections of these properties may be reduced by constraining the modeled quantities to observables. The article examines how such relationships emerge from Earth system models, simple theories for how ECs can be derived from temporal variability in the climate system, and how ECs might be misinterpreted. A wide range of ECs discovered so far are presented as well as a framework for quantifying multiple sources of uncertainty in ECs. An outlook for reducing these uncertainties to quantify global environmental change is also given.

025005 **Circuit quantum electrodynamics**

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This review surveys the development over the last 15 years of circuit quantum electrodynamics, the nonlinear quantum optics of microwave electrical circuits. In analogy to cavity quantum electrodynamics, lasers are replaced by rf signal generators, optical cavities by superconducting resonators, and atoms by superconducting qubits. Circuit QED offers enhanced light-matter coupling in which strong quantum optical nonlinearities are observable at the level of individual photons. This new parameter regime leads to unique capabilities for fundamental studies in quantum optics, nearly ideal quantum-limited measurements, and quantum computation.

025006 **Angle-resolved photoemission studies of quantum materials**

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Angle-resolved photoemission (ARPES) has evolved into a precision probe of electronic structure in momentum space of novel quantum materials. This review of a rapidly expanding field summarizes the technical advances leading to an increasing resolution and understanding of quantum materials, including copper- and iron-based superconductors, low-dimensional systems, topological materials, heavy fermions, and many magnetic systems. ARPES is presented as an accessible tool well situated to make advances in our understanding of the electronic structure of novel quantum materials.

025007 **Vector bosons and jets in proton collisions**

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Events with vector bosons produced in association with jets have been studied at hadron colliders and provide high-accuracy tests of the standard model. A good understanding of these processes is of paramount importance for precision measurements, including Higgs physics, and for searches for new physics. This review summarizes the theoretical achievements and the state of the art in the modeling of vector-boson-plus-jet physics. It also presents broad experimental results from the Fermilab Tevatron and the CERN LHC colliders and their comparison with the theory.

025008 **Equilibrium mechanisms of self-limiting assembly**

Michael F. Hagan
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Self-assembly is a process in which multiple building blocks spontaneously organize into collective and coherent ordered structures. This process is ubiquitous in soft synthetic and biological systems with examples ranging from lipid membranes, surfactant micelles, virus capsids, and bilayer vesicles to multiprotein filaments. This article provides a review on self-limiting assembly, which is the formation and stability of finite-size equilibrium structures, i.e., assemblies that are larger than the size of the building blocks and smaller than macroscopic bulk phases.

025009 **Near-field radiative heat transfer in many-body systems**

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Near-field radiative heat transfer refers to the transport of thermal energy by electromagnetic radiation between objects separated by less than a thermal wavelength. It involves tunneling processes that can lead to large deviations from Planck's law for blackbody radiation. These problems are of interest at a fundamental level and for devices that exploit heat transport on the nanoscale. This review summarizes the current state of this important field.

025010 **CODATA recommended values of the fundamental physical constants: 2018**

Eite Tiesinga
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This review article contains the 2018 self-consistent set of values of the constants and conversion factors of physics and chemistry recommended by the Committee on Data for Science and Technology (CODATA).The CODATA values are based on a least-squares adjustment that takes into account all data available up to the end of 2018. Details of the data selection and methodology are described.