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041001 ***Colloquium*: Atomic spin chains on surfaces**

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Low-dimensional physical systems are characterized by unusual behavior due to strong quantum fluctuations and electron-electron interactions which arise from the confinement of electrons. The capability of tuning interactions and geometry of one-dimensional (1D) systems is an opportunity to test the limits of quantum systems. In this Colloquium the physics of 1D spin chains on surfaces is discussed from the experimental and theoretical points of view. Also discussed are the opportunities in emerging areas of research such as quantum computation and communication and spintronics.

041002 ***Colloquium*: The physics of axion stars**

Eric Braaten
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Axions, which can explain the lack of *CP* violation in QCD, are also prime candidates for dark matter. Under the action of gravity, QCD axions condense into Bose-Einstein condensates called axion stars. In this Colloquium the properties of axion stars and self-bound Bose-Einstein condensates of axions are described. This important and timely summary of axion star research should motivate new strategies for dark matter axion searches.

041003 ***Colloquium*: Ice rule and emergent frustration in particle ice and beyond**

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Complex behavior in soft materials comes from the interactions between its components and geometrical constraints associated with lattice structures. Frustration is one classical example of such complex behavior leading to a plethora of phases and new phenomena. In this Colloquium the case of the ice rule is discussed and how it reflects in other soft materials.

045001 **Shortcuts to adiabaticity: Concepts, methods, and applications**

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Adiabatic evolution along the instantaneous eigenstate of a time-dependent Hamiltonian is used for robust and high fidelity state transfer in atomic and molecular physics. Shortcuts to adiabaticity (STA) are systematic approaches to accomplish the same final state transfer in a faster manner. This article presents an introduction to STA and reviews different theoretical approaches and applications of STA to a range of scientific and engineering tasks in quantum physics and beyond.

045002 **Machine learning and the physical sciences**

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In October 2018 an APS Physics Next Workshop on Machine Learning was held in Riverhead, NY. This article reviews and summarizes the proceedings of this very broad, emerging field.

045003 **Jet substructure at the Large Hadron Collider**

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Alexander Schmidt
Lily Asquith
Emma Winkels
Mario Campanelli
Chris Delitzsch
Philip Harris
Andreas Hinzmann
Deepak Kar
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Yuta Takahashi
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Caterina Vernieri
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Jets are collimated sprays of particles produced in abundance in high energy particle collisions and play a central role in the physics of fundamental particles: they provide key insights into the structure of the strong force and are indispensable in the study of the couplings of the Higgs boson to heavy quarks. Investigations of jet substructure enable measurements in unexplored kinematic regimes and may reveal new processes, while posing interesting theoretical and experimental challenges particularly in the era of the CERN Large Hadron Collider. This article reviews the development and use of the jet substructure techniques by ATLAS and CMS experiments at the LHC.

045004 **Nonequilibrium physics in biology**

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Life is made of active matter that operates out of thermodynamic equilibrium by consuming energy. The nonequilibrium physics that connects the macroscopic feature of a living system from the molecular components making up the active matter is still not well understood. This review reports on major advances in the field of nonequilibrium dynamics and thermodynamics for bridging the knowledge gap in describing how biology works, from small molecular motors to aging, through the lens of a physicist.

045005 **Odd-frequency superconductivity**

Jacob Linder
Alexander V. Balatsky

The formation of Cooper pairs most commonly occurs in the form of a spin singlet, with an even-parity gap function. Alternatively, one can have spin-triplet pairing with an odd-parity gap. Berezinskii noticed long ago that spin-triplet pairing with a gap that has even parity, but is odd in time, is also allowed. This pairing was originally perceived as an unlikely possibility. It has been shown to be a candidate for the pairing realized in unusual superconductors, in Josephson junctions and even in platforms hosting Majorana fermions. This review discusses the current state of the theory as well as proposed experimental realizations.

049901 **Publisher's Note: *CP* violation in the B_s^0 system [Rev. Mod. Phys. 88, 45002 (2016)]**

Marina Artuso
Guennadi Borissov
Alexander Lenz

049902 **Erratum: Axions and the strong *CP* problem [Rev. Mod. Phys. 82, 557 (2010)]**

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