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035001 **Dynamics of resonant x-ray and Auger scattering**

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With high brightness and tunable resolution, x-ray synchrotron light sources have enhanced the ability to characterize materials. This experimental and theoretical overview of elastic and inelastic x-ray and resonant Auger element-specific scattering processes enabled by these tools provides an updated and comprehensive perspective on electron-nuclear dynamics together with the structural aspects of a broad variety of materials. Materials characterized using these techniques include liquids, gases, molecules, solids with correlated excitations, Mott insulators, and semiconductors.

035002 **The entropy of Hawking radiation**

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This article describes recent progress on the black hole information problem that involves a new understanding of how to calculate the entropy of the Hawking radiation.

035003 **QCD thermalization: *Ab initio* approaches and interdisciplinary connections**

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Evidence suggests that terrestrial accelerators can create energy densities yielding a state of matter called the quark-gluon plasma (QGP). The QGP is the result of thermalization in quantum chromodynamics. Terrestrial accelerators collide protons and nuclei where the initial stages of interactions are far out of equilibrium. This review considers two limits: the weak-coupling, high occupation limit and the strong-coupling limit. While there is much room between these limits, a universal phenomenon used to classify these broad descriptions is presented. This also demonstrates connections to strongly correlated systems in atomic and condensed-matter physics, in cosmology, and to a holographic correspondence between strongly coupled theories and their gravitational duals.

035004 **Baryogenesis from the weak scale to the grand unification scale**

Dietrich Bödeker
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The standard model of elementary particle physics, once augmented with Sakharov's conditions, offers several scenarios to explain today's matter-antimatter asymmetry. This survey evaluates the paths to baryogenesis. Of special interest is that time-reversal violation in neutrino physics, together with large mixings, seems poised to produce the observed asymmetry via lepto-genesis. This review occurs at a time when several experiments are on the threshold of a precise measurement of time violation in lepton mixing.

035005 **Large-momentum effective theory**

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It is an art to match partons defined in the infinite-momentum frame to QCD lattice simulations. Large-momentum effective theory relates properties of Feynman's partons to partons of finite momentum, using asymptotic freedom to match the former's properties in the ultraviolet. Finite-momentum partons are then directly matched to nonperturbative QCD quantities. While reviewing recent developments, this article demonstrates its use in extracting physics from ***ab initio*** lattice calculations.

035006 **Wall interactions of spin-polarized atoms**

Zhen Wu

Experiments with polarized atoms in glass cells show that spin polarization and quantum coherence can survive many collisions of the atoms with the walls, depending on the nature of the wall interactions. This article reviews the physics of the wall interactions of spin-polarized atoms and the experience gained over decades in a field still developing and finding applications in a range of quantum technologies.

035007 **Dark matter annihilation to neutrinos**

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Astrophysical and cosmological evidence suggests that 85% of the mass in the Universe is not visible. This dark matter has yet to be incorporated into the standard model of particle physics. A leading candidate for dark matter is the weakly interacting massive particle. The production of weakly interacting dark matter in the early Universe implies possible ongoing self-annihilation to the standard model particles wherever dark matter exists today. This article provides a review of probes for the annihilation of dark matter into neutrinos over many orders of magnitude of dark matter mass. It reviews the experimental techniques that are used to detect neutrinos, places updated constraints on the dark matter self-annihilation cross section to neutrinos using recently available data, and forecasts the sensitivity of upcoming neutrino experiments.

035008 **Irreversible entropy production: From classical to quantum**

Gabriel T. Landi
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Entropy is a fundamental concept in thermodynamics and statistical physics. It governs processes in physics, chemistry, and biology, and its statistical and information theoretical foundations have been supplemented by recent analyses of fluctuations in microscopic and quantum systems. This article presents a review of theoretical and experimental attempts to describe and assess entropy production in a unified manner from the quantum to the classical level.