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020501 **Nobel Lecture: A forty-year journey** — Reinhard Genzel

The 2020 Nobel Prize for Physics was shared by Roger Penrose, Andrea Ghez, and Reinhard Genzel. This paper is the text of the address given in conjunction with the award.

025001 **Parameter estimation with gravitational waves** — Nelson Christensen, Renate Meyer

Following their first detection, gravitational wave signals from astrophysical binary mergers have been collected by the LIGO-Virgo network of interferometers, inaugurating the era of gravitational wave astronomy. With a new generation of instruments, one major challenge is the development of statistical and computational methods for estimating the physical parameters that characterize the emitting systems and the source populations. This review presents the Bayesian inference techniques used for parameter estimation from gravitational wave observations by ground-based interferometers. The application of such methods to the signals observed by LIGO-Virgo is illustrated with results in fundamental physics, astrophysics, and cosmology.

025002 **Interfacial thermal resistance: Past, present, and future** — Jie Chen, Xiangfan Xu, Jun Zhou, Baowen Li

As devices and circuits scale to ever smaller sizes and thermal management in them becomes more important, heat transport across their interfaces plays a crucial role in their development. While the study of interfacial thermal resistance goes back almost 90 years, its increasing importance has led to significant recent progress in theory, experiment, and simulation. This review chronicles this progress for solid-solid, solid-liquid, and solid-gas interfaces, discusses how to tailor interfaces to minimize the resistance, and mentions some of the remaining challenges.

025003 **Coupling of mechanical deformation and electromagnetic fields in biological cells** — Mehdi Torbati, Kosar Mozaffari, Liping Liu, Pradeep Sharma

A distinctive characteristic of the biological cell is its ability to mechanically deform to crawl or squeeze through trapped spaces. When a cell is taken apart, the structural deformation of its cellular components as biological matter can be manipulated by electrical and magnetic fields. Their response to the external fields opens an opportunity for biomedical intervention of controlling the movement of a cell. The understanding of the coupling between the mechanical deformation and the nonlinear electromagnetic behavior, however, requires the formulation of electrostatics and continuum mechanics in elastic material. This review reports on several major advances in elucidating the physics of biological matter and surveys new challenges pertinent to cellular biomechanics.

025004 **Spoof surface plasmon photonics**

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Structuring metallic surfaces allows for the support of surface electromagnetic modes at frequencies for which they would not be allowed for smooth surfaces. These modes are called "spoof surface plasmons" because of their similarity to surface plasmons that are supported at optical frequencies for smooth surfaces. This article describes the physics that underlies the behavior of spoof surface plasmons and how these modes are used in applications that require the manipulation of electromagnetic fields at frequencies below optical.

025005 **Tensor lattice field theory for renormalization and quantum computing**

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Ryo Sakai
Judah Unmuth-Yockey

One goal in understanding quantum chromodynamics (QCD) includes solving how quarks and gluons combine to form the hadrons and nuclei seen in nature. With lattice QCD, progress has been made regarding the calculation of masses and couplings. However, the real-time evolution and the critical behavior at finite density of strong particles in colliders, stars, or after the big bang remain a challenging problem despite their potential to detect the existence of new physics. The tensor methods for lattice field theories provide a route to handle strongly correlated systems across different subfields using renormalization group methods or quantum computing.

025006 **Bunch shaping in electron linear accelerators**

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Electron beams from modern high performance accelerators power intense light sources such as free electron lasers and synchrotron light sources, as well as wakefield-based accelerating modules relying on plasmas or dielectric structures. The way the electron bunches are shaped in space and time controls the efficacy of how the electron beam radiates or interacts with structures. In this review the physics behind methods for controlling the mesoscopic electron-bunch properties, i.e., phase-space distributions, from an electron accelerator are discussed, from both a theoretical and an experimental perspective. The focus is on phase-space shaping methods relying on bounded external electromagnetic fields or self-generated velocity and radiation fields, and how they are implemented.

025007 **Quantum indistinguishability by path identity and with undetected photons**

Armin Hochrainer
Mayukh Lahiri
Manuel Erhard
Mario Krenn
Anton Zeilinger

The double-slit experiment manifests the duality between wave interference and the distinguishability of paths taken by a particle though an apparatus. This article reviews advanced developments of these concepts with pairs of particles, starting with experiments on quantum foundations with photon pairs in the 1990s. These experiments now form the basis for applications in quantum information as well as for spatial imaging and spectroscopy that is performed without ever detecting the photons that interacted with the object.

025008 **Security in quantum cryptography**

Christopher Portmann
Renato Renner

Secure communications is a vital need of the world, and the basic features of quantum mechanics seemingly offer fundamental new tools for achieving this security. But do these tools really work? This review gives due attention to the real-world problems with experimental quantum cryptography, but the heart of the review is an in-depth survey of the analyses developed to prove the security of the basic quantum techniques introduced by Wiesner, Ekert, Bennett, and Brassard. A broader set of cryptographic tasks have quantum aspects which are also discussed here.

029901 **Erratum: Hadronic molecules [Rev. Mod. Phys. 90, 015004 (2018)]**

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