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Editorial: A Tribute to the Arecibo Observatory

Véronique Van Elewyck and Dietrich Belitz

Rev. Mod. Phys. **98**, 010001 (2026) - Published 31 March, 2026

Three Colloquia honor the Arecibo Observatory's legacy, exploring its revolutionary impact on planetary radar studies, radio astronomy, and geospace science.

Colloquium: Convection-cloud chambers: Experiment and theory

Steven Krueger and Raymond A. Shaw

Rev. Mod. Phys. **98**, 011001 (2026) - Published 4 February, 2026

In warm clouds, drops grow into raindrops through both condensation and collision coalescence, but the observed rapid transition between these mechanisms remains difficult to theoretically explain. The convection-cloud chamber, which reproduces key phenomena such as turbulent fluctuations in droplet concentrations and supersaturation under controlled laboratory conditions, offers a promising approach to addressing this long-standing bottleneck in understanding in cloud physics. This Colloquium reviews the physics underlying the precipitation bottleneck, examines how convection-cloud chambers capture the essential processes, and synthesizes insights from experiments, theory, and computational models that bridge laboratory and atmospheric scales.

Colloquium: Multimessenger astronomy with continuous gravitational waves and future detectors

Benjamin J. Owen

Rev. Mod. Phys. **98**, 011002 (2026) - Published 10 March, 2026

The search for continuous gravitational waves from rotating neutron stars represents a key frontier of gravitational-wave astrophysics, with strong connections to electromagnetic astronomy, nuclear astrophysics, and condensed matter physics. This Colloquium discusses the detection prospects for these long-lived yet elusive signals in the upcoming generation of gravitational-wave detectors, emphasizing the importance of simultaneous electromagnetic observations. It also surveys the potential implications of such multimessenger observations for our understanding of the physical and astrophysical processes taking place in the extremely dense environments of their sources.

Colloquium: Planetary radar at the Arecibo Observatory

Michael C. Nolan, Lynn M. Carter, and Edgard G. Rivera-Valentín

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For more than two decades, the planetary radar installed at the Arecibo Telescope was the most sensitive instrument of its kind, harnessing the penetrating power of radio waves to perform observations of the (sub)surface of planets, moons, and asteroids in the Solar System—providing a unique perspective on those bodies that helped to drive *in situ* exploration. This Colloquium presents an overview of the scientific legacy of the Arecibo radar system, focusing on the period posterior to the Gregorian Update in the late 1990s until the unexpected demise of the telescope in 2020. After recalling the basics of planetary radar techniques, it reviews key Arecibo observations of Mercury, Venus, Mars, our Moon, and the Saturn system, and highlights its essential role in the characterization of a large sample of near-Earth asteroids and comets.

Colloquium: Radio astronomy with the Arecibo 305-m telescope: In contemporaneous context

Tapasi Ghosh and Chris Salter

Rev. Mod. Phys. **98**, 011004 (2026) - Published 31 March, 2026

The Arecibo Observatory, inaugurated in 1963 as the world's largest single-dish radio telescope, remained at the forefront of astronomy and atmospheric science for more than five decades, until its catastrophic collapse in December 2020. This Colloquium focuses on Arecibo's enduring legacy in radio astronomy, offering a historical perspective that emphasizes how successive major upgrades of the telescope continuously expanded its observational capabilities and scientific impact. It presents Arecibo's most influential contributions in topics as diverse as pulsar studies, the mapping of neutral hydrogen (HI) in the Milky Way and other galaxies, the characterization of the interstellar medium, the imaging of extragalactic radio sources with very long baseline interferometry (VLBI), the search for extraterrestrial intelligence (SETI), and being a major contributor to the first-ever detection of a stochastic gravitational-wave background.

Colloquium: Geospace pathfinder science at Arecibo Observatory

J. D. Mathews, M. P. Sulzer, and Shikha Raizada

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The Arecibo Observatory housed the largest single-aperture radio telescope for approximately 50 years. A major scientific focus was studying the upper atmosphere; its highly sensitive radar facility, combined with lidars, optical sensors, and satellite-based systems, enabled unprecedented studies of ionospheric physics based on incoherent scattering of radio waves off free electrons. After establishing the fundamental concepts and observables of the incoherent scattering radar technique, this Colloquium reviews key advances obtained with the Arecibo suite of instruments in multiple areas of geospace science, including plasma physics, space weather, lidar studies of atomic metals in the ionosphere, and ionosphere-magnetosphere coupling.

Field theories and quantum methods for stochastic reaction-diffusion systems

Mauricio J. del Razo, Tommaso Lamma, and Wout Merbis

Rev. Mod. Phys. **98**, 015001 (2026) - Published 22 January, 2026

The exchange of energy and molecules in a living cell, the spread of opinions through a society, and the flow of traffic in a crowded city are very different phenomena, yet they are all examples of complex systems composed of many agents that interact with each other and exchange energy or particles with the environment. These systems can be modeled as stochastic reaction-diffusion systems. In this pedagogical review, the authors apply powerful field-theoretic methods to these systems, unifying diverse approaches under a single framework. The methods are useful for handling chemical systems but also have applications in a wide range of areas such as ecology and epidemiology.

Kagome metals

Domenico Di Sante, Titus Neupert, Giorgio Sangiovanni, Ronny Thomale, Riccardo Comin, Joseph G. Checkelsky, Ilija Zeljkovic, and Stephen D. Wilson

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The kagome lattice is a two-dimensional tiling of hexagons and triangles named after a Japanese basket weaving technique. Its geometry gives rise to highly frustrated interactions and interference effects experienced by electrons and their multiple degrees of freedom. In metals, the exploration of materials with kagome conduction networks is driven by predictions of realizing new electronic states where these interference effects are dominant, amplifying electronic interactions and many-body effects. In these kagome metals, these amplified correlation effects in combination with spin-orbit coupling and other forms of frustration have given rise to a wealth of phenomena beyond expectations. These include unusual states and responses born from topological flat bands, massive Dirac fermions, sublattice interference effects at saddle points such as unconventional superconductivity, orbital antiferromagnetism and flux phases, amplified anomalous Hall effects, and electronic nematic states. This review examines the theoretical and experimental work on kagome metals, with the aim of elucidating fundamental mechanisms underlying the observed exotic phenomena.

Continuous-variable quantum communication

Vladyslav C. Usenko, Antonio Acín, Romain Alléaume, Ulrik L. Andersen, Eleni Diamanti, Tobias Gehring, Adnan A. E. Hajomer, Florian Kanitschar, Christoph Pacher, Stefano Pirandola, and Valerio Pruneri

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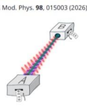

The quantum nature of radiation is not solely corpuscular. In the "continuous-variable" setting, the wavelike quantum properties can be observed. Quantum technologies put this continuous-variable nature of light to use, with applications in various forms of quantum information processing. This review concentrates on the developments of these wave-based techniques in quantum communication. Compared with photon-based (corpuscular) variants, the continuous-variable approach is equally well developed and has certain conceptual and practical advantages.

Pressure effects on metals, alloys, and compounds of transplutonium elements

Tyler W. Hines, Nicholas B. Beck, Kacy N. Mendoza, Joseph M. Sperling, and Thomas E. Albrecht

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Materials containing transplutonium elements (the actinides Am–Cm that come after Pu in the periodic table) are important for nuclear power, nuclear waste management, and long-term storage. They also have fascinating properties, with 5 electrons that lie at the boundary of being localized and itinerant. This paper reviews the physics and chemistry of transplutonium compounds under high pressure, covering both traditional metals, alloys, and compounds, as well as recent work on coordination complexes. Both the theory and experiments are challenging due to the high radioactivity and the complexity of studying heavy elements with both itinerant and localized electrons. The reviewed work represents a tour-de-force expansion of our understanding of the unique behavior of these materials.

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