

REVIEWS of MODERN PHYSICS

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- 1** **Compass models: Theory and physical motivations** Zohar Nussinov
Jeroen van den Brink
- Compass models describe systems in which the interaction between spin components, or more generally the vector components of any other degree of freedom, is other direction dependent. This concept is important in systems as diverse as Mott insulators, quantum magnets, and cold atoms. This review describes the physical ideas behind the construction of these models, as well as a host of analytical and numerical results.
- 61** **Dielectric microcavities: Model systems for wave chaos and non-Hermitian physics** Hui Cao
Jan Wiersig
- The quest to achieve optimal directional radiation from microlasers has stimulated numerous investigations in the field of dielectric microresonators which play an important role in fundamental and applied research. This review focuses on a comprehensive discussion of recent results from experimental and theoretical studies ranging from tailoring resonator shapes for directed light emission, mode interactions occurring at avoided resonance crossings, and non-Hermitian physics to wave chaotic properties of dielectric microwave cavities.
- 113** ***Colloquium: 100 years of mass spectrometry: Perspectives and future trends*** Simon Maher
Fred P. M. Jjunju
Stephen Taylor
- Mass spectroscopy was established more than 100 years ago and has been an invaluable experimental tool for many disciplines in science and engineering. This Colloquium is not only a great resource to the mass spectroscopy aficionado but will also be a useful reference for students and young researchers starting in this or in adjacent fields.
- 137** ***Colloquium: Majorana fermions in nuclear, particle, and solid-state physics*** Steven R. Elliott
Marcel Franz
- In nature one can associate to each particle an antiparticle with equal mass and opposite charge: to the electron there is the positron, to the proton there is an antiproton, etc. When they meet particles and antiparticles annihilate each other producing light in the process. Majorana fermions are particles with an identity crisis: they are their own antiparticles and hence they self-annihilate. Although they have been theoretically predicted to exist, they are recondite and only recently traces were found of their existence. In this Colloquium the nature of Majorana particles and their presence in several different branches of physics is discussed from nuclear to condensed matter.

- 165** **Colloquium: Time-reversal violation with quantum-entangled B mesons** J. Bernabéu
F. Martínez-Vidal
- One of the most important symmetries in nature is time reversal, namely, that the laws of physics remain dynamically invariant from moving forward to backward in time. Nevertheless, this symmetry can be broken in certain physical processes as observed in neutral B mesons by the **BABAR** Collaboration. This Colloquium reviews this important result and its broad implications in physical phenomena.
- 183** **Colloquium: Random first order transition theory concepts in biology and physics** T. R. Kirkpatrick
D. Thirumalai
- Glassy systems are characterized by multiple time and length scales and, due to their intrinsic complexity, have been the source of much debate for decades. This Colloquium describes the random first order transition theory of the structural glass transition and how its basic ideas can be used to understand aspects of biological systems and other condensed matter problems. It is suggested that universality underlies the glassy behavior of a large class of seemingly unrelated materials, both synthetic and biological.
- 211** **Baryon resonances in large N_c QCD** N. Matagne
Fl. Stancu
- This review summarizes baryon resonances from QCD in the large N_c expansion and a comparison with lattice is made. These techniques are more intricate for excited baryons with mixed symmetries. Modern approaches which address this problem exist using symmetry arguments as well as consistency with both scattering data and the quark model. Bringing clarity to this important subject could provide semiphenomenological light on the structure of QCD baryons.
- 247** **Plasma and trap-based techniques for science with positrons** J. R. Danielson
D. H. E. Dubin
R. G. Greaves
C. M. Surko
- The study of antimatter has been greatly advanced recently through the development of traps, which use plasma-based techniques. Such traps allow storage of antimatter for long times and the formation of tailored bursts for a wide range of applications. This article reviews the use of traps for positrons to study antimatter physics including positron-matter interactions, electron-positron plasmas, antihydrogen and dynamics of antimatter in gravitational fields.