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030001 **Editorial: RMP: Looking Forward**

Randall D. Kamien
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Igor Klebanov
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Klaus Mølmer
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Pierre Ramond
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Anthony F. Starace
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030501 **Nobel Lecture: Extreme light physics and application**

Gerard Mourou

The 2018 Nobel Prize for Physics was shared by Gerard Mourou, Arthur Askin, and Donna Strickland. These papers are the text of the address given in conjunction with the award.

030502 **Nobel Lecture: Generating high-intensity ultrashort optical pulses**

Donna Strickland

The 2018 Nobel Prize for Physics was shared by Gerard Mourou, Arthur Askin, and Donna Strickland. These papers are the text of the address given in conjunction with the award.

031001 ***Colloquium*: Proteins: The physics of amorphous evolving matter**

Jean-Pierre Eckmann
Jacques Rougemont
Tsvi Tlusty

Thought of as inert matter, proteins present a challenge to the methods of statistical mechanics and materials science. Unlike systems in or near equilibrium, protein structure has evolved over the eons. In this Colloquium, a framework to study polypeptide structure and evolution is proposed that employs the tools of correlation and response to these adapted and highly functional biomolecules.

035001 **Cold hybrid ion-atom systems**

Michał Tomza
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Rene Gerritsma
Antonio Negretti
Tommaso Calarco
Zbigniew Idziaszek
Paul S. Julienne

This article presents the microscopic physics governing interactions and dynamical processes between cold atoms and ions, and it reviews how these systems can be prepared and combined in experiments. Also discussed are how ultracold ion-atom hybrid systems can be applied to study controlled chemical reactions, to form and explore the spectroscopy of cold molecular ions, and to implement quantum simulations of many-body phenomena.

035002 **Memory formation in matter**

Nathan C. Keim
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Zorana Zeravcic
Srikanth Sastry
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Many forms of memory can be stored in the materials around us. Examples are hysteresis in magnets, aging and rejuvenation in glasses, shape memory in alloys, and echoes in spin systems and capillary waves. Once the material is fully equilibrated, memory of the system's initial conditions or previous history is completely lost. Memory is thus intimately connected to out-of-equilibrium behavior. This paper reviews examples where specific inputs can be stored in condensed-matter systems and then retrieved by appropriate protocols. It describes some common principles and questions that emerge from looking for the underlying shared elements in these apparently disparate systems.

035003 **Superradiant and stimulated-superradiant emission of bunched electron beams**

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Electron beams can generate radiation spanning a wide range of the electromagnetic spectrum. Creating temporal structure in the beam density results in intense radiation emission proportional to the square of the particle number as compared to the linear dependence on particle number from a randomly distributed electron beam. In this article various coherent radiation emission processes are discussed including spontaneous emission, coherent spontaneous superradiance, and stimulated superradiance.

035004 **Current-induced spin-orbit torques in ferromagnetic and antiferromagnetic systems**

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The field of spintronics, that is, the use of spin-charge coupling in solid-state devices, is both of fundamental interest and great promise for practical applications, resistive random access memory being a prime example. Recently the transfer of orbital angular momentum to the spin system in materials with a strong spin-orbit coupling in conjunction with a broken spatial inversion symmetry has emerged as a particularly promising further development of this idea. This review discusses the theoretical and experimental aspects of such spin-orbit torques induced by electrical currents.

035005 **Quantum control of molecular rotation**

Christiane P. Koch
Mikhail Lemeshko
Dominique Sugny

Rotation is a fundamental degree of freedom of isolated molecules and a property that affects their interaction with other physical systems. This article reviews theory and a multitude of experimental methods aiming to control molecular rotation. Applications include studies of a variety of single-particle quantum phenomena, controlled molecular collisions, and rotational dynamics in solvents, as well as the perspective use of long distance dipolar interactions to simulate many-body Hamiltonians.

035006 **Optoelectronic oscillators with time-delayed feedback**

Yanne K. Chembo
Daniel Brunner
Maxime Jacquot
Laurent Larger

The optoelectronic oscillator is an autonomous system where electronic and optical signals act on each other in a feedback loop. This oscillator has found several applications in optics and microwave photonics and has also permitted one to explore the rich and complex dynamical properties of nonlinear time-delayed systems. This article reviews theoretical and experimental developments, including applications for communication, sensing, ultrapure microwave generation, and neuromorphic computing.