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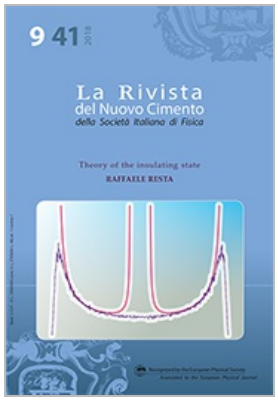
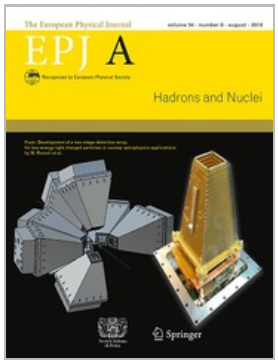
La Rivista del Nuovo Cimento Vol. 41 N. 9 (2018)
Theory of the insulating state
R. Resta



All undergraduates learn that Bloch theorem and band structure explain the insulating/metallic behavior of most crystalline solids. Nonetheless there exist materials to which band theory does not apply: most notably Mott insulators, where the insulating character is due to electron-electron interaction, and Anderson insulators, where it is due to lattice disorder.
The modern theory provides a comprehensive characterization of the insulating state of matter; at its root is the key observation that the static polarization of a metallic sample is qualitatively different from the polarization of an insulating one. While in metals the macroscopic polarization is trivial, material-independent (Faraday-cage effect), in insulators it is nontrivial and material-dependent, both with and without an applied field. In the 1990s it became clear that the polarization of an insulator is a geometric phase (Berry phase) of the electronic ground state. In the following years this advance was exploited to provide a geometrical characterization of the insulating state of matter.
This review starts with an outline of the modern theory of polarization, followed by a thorough investigation of the geometry of the electronic ground state (insulating vs. metallic) in the appropriate parameter space. The most conventional characterization, based on dc conductivity, is also addressed.

EPJ A – Highlights
Solid deuterium surface degradation at ultracold neutron sources
A. Anghel et al.



Highest intensities of ultracold neutrons (UCN) are in worldwide demand for fundamental physics experiments. Tests of the Standard Model of particle physics and searches for physics beyond it are performed with UCN. Two of the leading UCN sources, at PSI and at LANL, are based on solid deuterium (sD2) at temperatures around 5 K. Here, together with NCSU they joined forces to understand UCN intensity decreases observed during pulsed neutron production. The study shows that the decrease can be completely explained by the build-up of frost on the sD2 surface during operation. Pulsed proton beams hitting the spallation targets generate heat pulses causing cycles of D2 sublimation and subsequent resublimation on the sD2 surface. Even very small frost flakes can act as total reflectors for UCN and cause an intensity decrease. Optical observation of the sD2 surface at NCSU – not possible at the operating spallation neutron sources – confirmed a severe surface degradation due to heat pulsing with an external heater in strong support of the frost model.

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EPJ E – Review

Physico-chemical foundations of particle-laden fluid interfaces

A. Maestro, E. Santini, E. Guzmán

In this EPJ E Topical Review, Armando Maestro and colleagues unravel the physico-chemical bases underlying the attachment of particles to fluid interfaces. Their focus is on the relaxation mechanisms involved in the equilibration of particle-laden interfaces. Particle-laden interfaces play a key role in many systems that are used in industrial and technological applications, such as the stabilization of foams, emulsions, or thin films, flotation processes, encapsulation, pharmaceutical formulations, food technology and catalysis. A big challenge for researchers in this field is finding a framework to describe the complex interplay between different physico-chemical properties, e.g. particle wettability, size, shape, surface charge, and chemical nature of the particles and the interface, with the relative dielectric constant of the phases playing a major role.

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EPJ Plus – Focus Point

Systems and Security: Advanced Methods with Chaos and Complexity

Edited by *S.Banerjee*

Complexity, as far as information theory is concerned, plays an important role in extracting the amount of uncertainty in dynamics. Several entropy-based measurements have been successfully implemented to quantify the divergence of a system. Uncertainty also plays an effective role, in the field of cryptography, in generating secret keys and to design the most secure model. Recently, real applications have been implemented considering the effect of dynamical complexity, in the field of optical communications, using semiconductor lasers. This EPJ Plus Focus Point edited by Santo Banerjee is a collection of research articles based on the recent developments of communication schemes using chaos and dynamical complexity. The results have been implemented with dynamical models, circuit design, complex networks along with their applications in image, video and optical communications.

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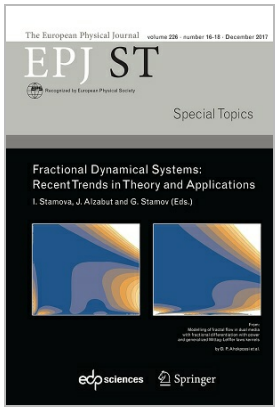
EPJ – Call for papers

EPJ ST Special Issue: Nonextensive Statistical Mechanics, Superstatistics and Beyond: Theory and Applications in Astrophysical and Other Complex Systems



Guest Editors: *A. Rapisarda, C. Tsallis, C. Beck, G. Livadiotis, U. Tirnakli, G. Benedek*

Call for papers:

The Guest Editors invite authors to submit their original research and short reviews on the theme of the Special Issue of the European Physical Journal - Special Topics. Articles should be submitted to the Editorial Office of EPJ: ST by selecting the "Nonextensive Statistical Mechanics, Superstatistics and Beyond" as a special issue at: https://articlestatus.edpsciences.org/is/epjst/home.php.