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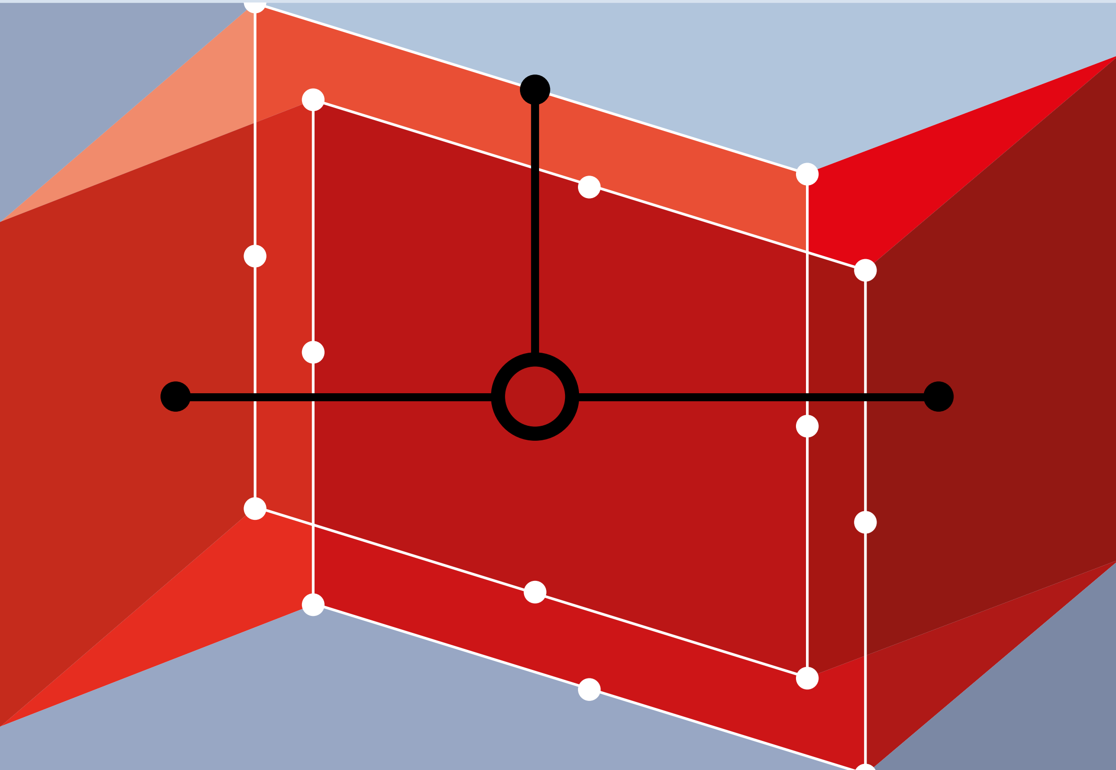
Highlights 2016

A compilation of the best papers published within the last year



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Welcome

Professor Giorgio Benedek
Editor-in-Chief, EPL

The first issue of *Europhysics Letters* was published in January 1986. We celebrated our 30th birthday with a few significant events: a special EPL session with three magnificent talks at the EPS Condensed Matter Division (CMD) Conference in Groningen in early September, EPL's support for the 2016 EPS CMD Prize, and, in early October, the Plenary Editorial Board Meeting in Como, associated with the EPS Edison Volta Prize ceremony.

The aim of this Highlights collection is to show, within the limited space available, that EPL excellently covers all the disciplinary and cross-disciplinary sections of physics, as listed in the contents. This booklet includes many of our Editor's Choice articles, and is complemented by other letters with high visibility. The full Highlights collection can be found online at **epljournal.org/highlights-2016**.

The first mission of EPL is the capillary dissemination of the best physics. A journal successfully offering this service to the physics community stimulates the best research and the production of the best papers, especially by young researchers aiming for worldwide visibility. For this reason, EPL is also sponsoring poster or best-presentation prizes for young scientists at many international meetings. The lists of meetings sponsored in 2016 and for 2017 events where EPL may be present with a sponsorship or an exhibit of materials are also listed in this booklet. If you are organizing a meeting and are interested in an EPL sponsorship, feel free to contact EPL at **info@epljournal.org**.

From the Executive Editor

Dr Graeme Watt
Executive Editor, EPL

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I hope that you enjoy the current selection of articles highlighted in this booklet. The full-text content of all the articles is freely available online throughout 2017. Thank you for your support and please continue to strengthen EPL with more top-quality submissions.

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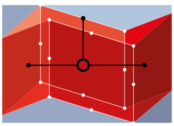
Contents



Front cover image: Sketch of the Brillouin zone of an In_2O_3 crystal, adapted from **V. Scherer, C. Janowitz, Z. Galazka, M. Nazarzadehmoafi and R. Manzke** 2016 *EPL* **113** 26003.

Quantum statistics, quantum systems, quantum mechanics & quantum information

INVITED RESEARCH ARTICLE

J. A. Blackburn

Frequency spectrum of a superconducting metadevice

J. A. Blackburn, M. Cirillo and N. Grønbech-Jensen

2016 *EPL* **115** 50004

We report on a systematic analysis of the frequency spectrum of a system often considered for quantum computing purposes, metadevice applications, and high-sensitivity sensors, namely a superconducting loop interrupted by Josephson junctions, the core of an rf-SQUID. We analyze both the cases in which a single junction closes the superconducting loop and the one in which the single junction is replaced by a superconducting interferometer. Perturbation analysis is employed to display the variety of the solutions of the system and the implications of the results for the present interest in fundamental and applied research are analyzed.

OPEN ACCESS

J. Flakowski

H. C. Öttinger

Biexponential decay and ultralong coherence of a qubit

J. Flakowski, M. Osmanov, D. Taj and H. C. Öttinger

2016 *EPL* **113** 40003

A quantum two-state system, weakly coupled to a heat bath, is traditionally studied in the Born-Markov regime under the secular approximation with completely positive linear master equations. Despite its success, this microscopic approach exclusively predicts exponential decays and Lorentzian susceptibility profiles, in disagreement with a number of experimental findings. On the contrary, in the absence of the secular approximation they can be explained but with the risk of jeopardizing the positivity of the density matrix. To avoid these drawbacks, we use a physically motivated nonlinear master equation being both thermodynamically and statistically consistent. We find that, beyond a temperature-dependent threshold, a bifurcation in the decoherence time T_2 takes place; it gives rise to a biexponential decay and a susceptibility profile being neither Gaussian nor Lorentzian. This implies that, for suitable initial states, a major prolongation of the coherence can be obtained in agreement with recent experiments. Moreover, T_2 is no longer limited by the energy relaxation time T_1 offering novel perspectives to elaborate devices for quantum information processing.

QUANTUM STATISTICS, QUANTUM SYSTEMS, QUANTUM MECHANICS & QUANTUM INFORMATION

M. Ostilli

C. Presilla

Asymptotic lower bound for the gap of Hermitian matrices having ergodic ground states and infinitesimal off-diagonal elements

M. Ostilli and C. Presilla

2016 *EPL* **113** 40002

Given a $M \times M$ Hermitian matrix $\boldsymbol{H}$ with possibly degenerate eigenvalues $\varepsilon_1 < \varepsilon_2 < \varepsilon_3 < \ldots$, we provide, in the limit $M \to \infty$, a lower bound for the gap $\mu_2 = \varepsilon_2 - \varepsilon_1$ assuming that i) the eigenvector (eigenvectors) associated to ε_1 is ergodic (are all ergodic) and ii) the off-diagonal terms of $\boldsymbol{H}$ vanish for $M \to \infty$. Under these hypotheses, we find $\underline{\lim}_{M \to \infty} \mu_2 \geq \overline{\lim}_{M \to \infty} \min_n \boldsymbol{H}_{n,n}$. This general result turns out to be important for upper bounding the relaxation time of linear master equations characterized by a matrix equal, or isospectral, to $\boldsymbol{H}$. As an application, we consider symmetric random walks with infinitesimal jump rates and show that the relaxation time is upper bounded by the configurations (or nodes) with minimal degree.

Large deviations for the height in 1D Kardar-Parisi-Zhang growth at late times

Pierre Le Doussal, Satya N. Majumdar and Grégory Schehr

2016 *EPL* **113** 60004

We study the atypically large deviations of the height $H \sim O(t)$ at the origin at late times in (1 + 1)-dimensional growth models belonging to the Kardar-Parisi-Zhang (KPZ) universality class. We present exact results for the rate functions for the discrete single-step growth model, as well as for the continuum KPZ equation in a droplet geometry. Based on our exact calculation of the rate functions we argue that models in the KPZ class undergo a third-order phase transition from a strong-coupling to a weak-coupling phase, at late times.

QUANTUM STATISTICS, QUANTUM SYSTEMS, QUANTUM MECHANICS & QUANTUM INFORMATION

T. Chanda

U. Sen

Statistics of leading digits leads to unification of quantum correlations

T. Chanda, T. Das, D. Sadhukhan, A. K. Pal, A. Sen(De) and U. Sen

2016 *EPL* **114** 30004

We show that the frequency distribution of the first significant digits of the numbers in the data sets generated from a large class of measures of quantum correlations, which are either entanglement measures or belong to the information-theoretic paradigm, exhibit a universal behavior. In particular, for Haar uniformly simulated arbitrary two-qubit states, we find that the first-digit distributions corresponding to a collection of chosen computable quantum correlation quantifiers tend to follow the first-digit law, known as Benford's law, when the rank of the states increases. Considering a two-qubit state which is obtained from a system governed by paradigmatic spin Hamiltonians, namely, the *XY* model in a transverse field, and the *XXZ* model, we show that entanglement as well as information-theoretic measures violate Benford's law. We quantitatively discuss the violation of Benford's law by using a violation parameter, and demonstrate that the violation parameter can signal quantum phase transitions occurring in these models. We also comment on the universality of the statistics of the first significant digits corresponding to appropriate measures of quantum correlations in the case of multipartite systems as well as systems in higher dimensions.

Experimental test for approximately dispersionless forces in the Aharonov-Bohm effect

Maria Becker and Herman Batelaan

2016 *EPL* **115** 10011

A new class of forces, approximately dispersionless forces, were recently predicted as part of a semiclassical description of the Aharonov-Bohm effect. Electron time-of-flight measurements have been performed that test for such forces. Magnetized iron cores used in the previous time-of-flight experiment may affect potential back-action forces and have, therefore, been eliminated. We report that no forces were detected. This finding supports the local and nonlocal, quantum descriptions of the AB effect and rules out local, semiclassical descriptions.

QUANTUM STATISTICS, QUANTUM SYSTEMS, QUANTUM MECHANICS & QUANTUM INFORMATION

Young-Sea Huang

Critique and correction of the currently accepted solution of the infinite spherical well in quantum mechanics

Young-Sea Huang and Hans-Rudolf Thomann

2016 *EPL* **115** 60001

An error in the currently accepted solution of the problem of the infinite spherical well is pointed out. The problem is then solved by considering the self-adjointness of the Hamiltonian operator. In contrast to the currently accepted solution, the radial probability density for finding the particle at the center of the spherical well is not necessarily zero, in accordance with the solutions obtained.

Eric A. Galapon

Internal one degree of freedom is sufficient to induce exact decoherence

Eric A. Galapon

2016 *EPL* **113** 60007

Current quantum orthodoxy claims that the statistical collapse of the wave function arises from the interaction of the measuring instrument with its environment through the phenomenon known as environment-induced decoherence. Here it is shown that there exists a measurement scheme that is exactly decohering without the aid of an environment. The scheme relies on the assumption that the meter is decomposable into probe and pointer, with the probe taken to be inaccessible for observation. Under the assumption that the probe and the pointer initial states are momentum limited, it is shown that coherences die out within a finite measurement time and the pointer states are exactly orthogonal after a sufficiently longer time of measurement. Furthermore, it is shown that the measurement scheme reproduces the main result of the environment-induced decoherence theory that coherences decay asymptotically in time for a general initial state of the probe.

QUANTUM STATISTICS, QUANTUM SYSTEMS, QUANTUM MECHANICS & QUANTUM INFORMATION

Cusps in the quench dynamics of a Bloch state

J. M. Zhang and Hua-Tong Yang

2016 *EPL* **114** 60001

We report some nonsmooth dynamics of a Bloch state in a one-dimensional tight binding model with the periodic boundary condition. After a sudden change of the potential of an arbitrary site, quantities like the survival probability of the particle in the initial Bloch state show cusps periodically, with the period being the Heisenberg time associated with the energy spectrum. This phenomenon is a *nonperturbative* counterpart of the nonsmooth dynamics observed previously (Zhang J. M. and Haque M., arXiv:1404.4280) in a periodically driven tight binding model. Underlying the cusps is an exactly solvable model, which consists of equally spaced levels extending from $-\infty$ to $+\infty$, between which two arbitrary levels are coupled to each other by the same strength.

M. Tettamanti

I. Carusotto

Numerical study of a recent black-hole lasing experiment

M. Tettamanti, S. L. Cacciatori, A. Parola and I. Carusotto

2016 *EPL* **114** 60011

We theoretically analyse a recent experiment reporting the observation of a self-amplifying Hawking radiation in a flowing atomic condensate (Steinhauer J., *Nat. Phys.,* **10** (2014) 864). We are able to accurately reproduce the experimental observations using a theoretical model based on the numerical solution of a mean-field Gross-Pitaevskii equation that does not include quantum fluctuations of the matter field. In addition to confirming the black-hole lasing mechanism, our results show that the underlying dynamical instability has a classical hydrodynamic origin and is triggered by a seed of deterministic nature, linked to the non-stationary of the process, rather than by thermal or zero-point fluctuations.

Statistical physics, thermodynamics & nonlinear dynamical systems

P. Jakubczyk

Repulsive Casimir forces at quantum criticality

P. Jakubczyk, M. Napiórkowski and T. Sęk

2016 *EPL* **113** 30006

We study the Casimir effect in the vicinity of a quantum-critical point. As a prototypical system we analyze the d-dimensional imperfect (mean-field) Bose gas enclosed in a slab of extension $L^{d-1} \times D$ and subject to periodic boundary conditions. The thermodynamic state is adjusted so that $L \gg \lambda \gg D \gg l_{mic}$, where $\lambda \sim T^{-1/2}$ is the thermal de Broglie length, and l_{mic} denotes microscopic length scales. Our exact analysis indicates that the Casimir force in the above-specified regime is generically repulsive and decays either algebraically or exponentially, with a non-universal amplitude.

Heino Soo

Fluctuational electrodynamics for nonlinear media

Heino Soo and Matthias Krüger

2016 *EPL* **115** 41002

We develop fluctuational electrodynamics for media with nonlinear optical response. In a perturbative manner, we amend the stochastic Helmholtz equation to describe fluctuations in a nonlinear setting, in agreement with the fluctuation dissipation theorem, and identify the local (Rytov) fluctuations of electric currents. We show how the linear response (the solution of the scattering problem) of a collection of objects is found from the individual responses, as measured in isolation. As an example, we compute the Casimir force acting between nonlinear objects which approaches the result for linear optics for large separations, and deviates for small distances.

STATISTICAL PHYSICS, THERMODYNAMICS & NONLINEAR DYNAMICAL SYSTEMS

Jaco Fuchs

Stochastic thermodynamics of resetting

Jaco Fuchs, Sebastian Goldt and Udo Seifert

2016 *EPL* **113** 60009

Stochastic dynamics with random resetting leads to a non-equilibrium steady state. Here, we consider the thermodynamics of resetting by deriving the first and second law for resetting processes far from equilibrium. We identify the contributions to the entropy production of the system which arise due to resetting and show that they correspond to the rate with which information is either erased or created. Using Landauer's principle, we derive a bound on the amount of work that is required to maintain a resetting process. We discuss different regimes of resetting, including a Maxwell demon scenario where heat is extracted from a bath at constant temperature.

Momčilo Gavrilov

John Bechhoefer

Arbitrarily slow, non-quasistatic, isothermal transformations

Momčilo Gavrilov and John Bechhoefer

2016 *EPL* **114** 50002

For an overdamped colloidal particle diffusing in a fluid in a controllable, virtual potential, we show that arbitrarily slow transformations, produced by smooth deformations of a double-well potential, need not be reversible. The arbitrarily slow transformations do need to be fast compared to the barrier crossing time, but that time can be extremely long. We consider two types of cyclic, isothermal transformations of a double-well potential. Both start and end in the same equilibrium state, and both use the same basic operations—but in different order. By measuring the work for finite cycle times and extrapolating to infinite times, we found that one transformation required no work, while the other required a finite amount of work, no matter how slowly it was carried out. The difference traces back to the observation that when time is reversed, the two protocols have different outcomes, when carried out arbitrarily slowly. A recently derived formula relating work production to the relative entropy of forward and backward path probabilities predicts the observed work average.

STATISTICAL PHYSICS, THERMODYNAMICS & NONLINEAR DYNAMICAL SYSTEMS

Approximate scale invariance in particle systems: A large-dimensional justification

Thibaud Maimbourg and Jorge Kurchan

2016 *EPL* **114** 60002

Systems of particles interacting via inverse-power law potentials have an invariance with respect to changes in length and temperature, implying a correspondence in the dynamics and thermodynamics between different "isomorphic" sets of temperatures and densities. In a recent series of works, it has been argued that such correspondences hold to a surprisingly good approximation in a much more general class of potentials, an observation that summarizes many properties that have been observed in the past. In this paper we show that such relations are exact in high-dimensional liquids and glasses, a limit in which the conditions for these mappings to hold become transparent. The special role played by the exponential potential is also confirmed.

Hongya Xu

Ying-Cheng Lai

A robust relativistic quantum two-level system with edge-dependent currents and spin polarization

Hongya Xu, Liang Huang and Ying-Cheng Lai

2016 *EPL* **115** 20005

We consider a class of relativistic quantum systems of ring geometry with mass confinement, subject to a magnetic flux. Such a system supports a family of boundary modes with edge-dependent currents and spin polarization as the spinor-wave analog of the whispering-gallery modes. While these states are remarkably robust against random scattering, boundary deformations and/or bulk disorders can couple the two oppositely circulating base states. Superposition of the two states can be realized by sweeping an external magnetic flux. We also address the issue of decoherence and articulate a possible experimental scheme based on 3D topological insulators.

STATISTICAL PHYSICS, THERMODYNAMICS & NONLINEAR DYNAMICAL SYSTEMS

Zhedong Zhang

Jin Wang

Fluctuation-dissipation theorem for nonequilibrium quantum systems

Zhedong Zhang, Wei Wu and Jin Wang

2016 *EPL* **115** 20004

We present a fluctuation-dissipation theorem (FDT) for nonequilibrium quantum systems with detailed-balance breaking, which deviates from the conventional form of the FDT for equilibrium systems preserving detailed balance. Using the phase space formulation of quantum mechanics and the potential-flux landscape framework, we find that the response function of nonequilibrium quantum systems to external perturbations contains a nontrivial contribution from the quantum curl flux quantifying detailed-balance breaking in the steady state, in addition to the correlation function of observables in the steady state representing the contribution of spontaneous fluctuations which is also present in the equilibrium FDT. We illustrate our general formalism with a harmonic oscillator coupled to two heat baths, and show that the nonequilibrium FDT reduces to the conventional expression at the equilibrium condition when the flux contribution vanishes.

Steffen Lange

What is the mechanism of power-law distributed Poincaré recurrences in higher-dimensional systems?

Steffen Lange, Arnd Bäcker and Roland Ketzmerick

2016 *EPL* **116** 30002

The statistics of Poincaré recurrence times in Hamiltonian systems typically shows a power-law decay with chaotic trajectories sticking to some phase-space regions for long times. For higher-dimensional systems the mechanism of this power-law trapping is still unknown. We investigate trapped orbits of a generic 4D symplectic map in phase space and frequency space and nd that, in contrast to 2D maps, the trapping is (i) not due to a hierarchy in phase space. Instead, it occurs at the surface of the regular region, (ii) outside of the Arnold web. The chaotic dynamics in this sticky region is (iii) dominated by resonance channels which reach far into the chaotic region: We observe (iii.a) clear signatures of some kind of partial transport barriers and conjecture (iii.b) a stochastic process with an effective drift along resonance channels. These two processes lay the basis for a future understanding of the mechanism of power-law trapping in higher-dimensional systems.

STATISTICAL PHYSICS, THERMODYNAMICS & NONLINEAR DYNAMICAL SYSTEMS

Léo Granger

Juan M. R. Parrondo

Reversible feedback confinement

Léo Granger, Luis Dinis, Jordan M. Horowitz and Juan M. R. Parrondo

2016 *EPL* **115** 50007

We present a feedback protocol that is able to confine a system to a single micro-state without heat dissipation. The protocol adjusts the Hamiltonian of the system in such a way that the Bayesian posterior distribution after measurement is in equilibrium. As a result, the whole process satisfies feedback reversibility—the process is indistinguishable from its time reversal—and assures the lowest possible dissipation for confinement. In spite of the whole process being reversible it can surprisingly be implemented in finite time. We illustrate the idea with a Brownian particle in a harmonic trap with increasing stiffness and present a general theory of reversible feedback confinement for systems with discrete states.

Alexey Yu. Jalnine

Strange nonchaotic self-oscillator

Alexey Yu. Jalnine and Sergey P. Kuznetsov

2016 *EPL* **115** 30004

An example of strange nonchaotic attractor (SNA) is discussed in a dissipative system of mechanical nature driven by a constant torque applied to one of the elements of the construction. So the external force is not oscillatory, and the system is autonomous. Components of the motion with incommensurable frequencies emerge due to the irrational ratio of the sizes of the involved rotating elements. We regard the phenomenon as strange nonchaotic self-oscillations, and its existence sheds new light on the question of feasibility of SNA in autonomous systems.

Temperature response in nonequilibrium stochastic systems

Gianmaria Falasco and Marco Baiesi

2016 *EPL* **113** 20005

The linear response to temperature changes is derived for systems with overdamped stochastic dynamics. Holding both in transient and steady-state conditions, the results allow to compute nonequilibrium thermal susceptibilities from unperturbed correlation functions. These correlations contain a novel form of entropy flow due to

STATISTICAL PHYSICS, THERMODYNAMICS & NONLINEAR DYNAMICAL SYSTEMS

temperature unbalances, next to the standard entropy flow of stochastic energetics and to complementary time-symmetric dynamical aspects. Our derivation hinges on a time rescaling, which is a key procedure for comparing apparently incommensurable path weights. An interesting notion of thermal time emerges from this approach.

V. Semenov

A. Zakharova

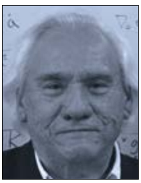
Delayed-feedback chimera states: Forced multiclusters and stochastic resonance

V. Semenov, A. Zakharova, Y. Maistrenko and E. Schöll

2016 *EPL* **115** 10005

A nonlinear oscillator model with negative time-delayed feedback is studied numerically under external deterministic and stochastic forcing. It is found that in the unforced system complex partial synchronization patterns like chimera states as well as salt-and-pepper–like solitary states arise on the route from regular dynamics to spatio-temporal chaos. The control of the dynamics by external periodic forcing is demonstrated by numerical simulations. It is shown that one-cluster and multi-cluster chimeras can be achieved by adjusting the external forcing frequency to appropriate resonance conditions. If a stochastic component is superimposed to the deterministic external forcing, chimera states can be induced in a way similar to stochastic resonance, they appear, therefore, in regimes where they do not exist without noise.

Julian Gonzalez-Ayala



F. Angulo-Brown

Is the (3 + 1)-d nature of the universe a thermodynamic necessity?

Julian Gonzalez-Ayala, Rubén Cordero and F. Angulo-Brown

2016 *EPL* **113** 40006

It is well established that at early times, long before the time of radiation-matter density equality, the universe could have been well described by a spatially flat, radiation only model. In this article we consider the whole primeval universe, as a first approach, as a black-body radiation system in an n-dimensional Euclidean space. We propose that the (3 + 1)-dimensional nature of the universe could be the result of a thermodynamic selection principle stemming from the second law of thermodynamics. In regard to the three spatial dimensions we suggest that they were chosen by means of the minimization of the Helmholtz free energy per hypervolume unit following possibly a kind of broken symmetry process, while the time dimension, as is well known, is related with the principle of increment of entropy for closed systems: the so-called arrow of time.

Elementary particles, fields & nuclear physics

Coordinate/field duality in gauge theories: Emergence of matrix coordinates

Amir H. Fatollahi

2016 *EPL* **113** 10001

The proposed coordinate/field duality (Faraggi A. E. and Matone M., *Phys. Rev. Lett.*, **78** (1997) 163) is applied to the gauge and matter sectors of gauge theories. In the non-Abelian case, due to indices originated from the internal space, the dual coordinates appear to be matrices. The dimensions and the transformations of the matrix coordinates of gauge and matter sectors are different and are consistent to expectations from lattice gauge theory and the theory of open strings equipped with the Chan-Paton factors. It is argued that in the unbroken symmetry phase, where only proper collections of field components as colorless states are detected, it is logical to assume that the same happens for the dual coordinates, making matrix coordinates the natural candidates to capture the internal dynamics of baryonic confined states. The proposed matrix coordinates happen to be the same appearing in the bound state of D0-branes of the string theory.

New physics and signal-background interference in associated pp → HZ production

Christoph Englert, Rogerio Rosenfeld, Michael Spannowsky and Alberto Tonero

2016 *EPL* **114** 31001

We re-investigate electroweak signal-background interference in associated Higgs production via gluon fusion in the presence of new physics in the top Higgs sector. Considering the full final state $pp \to b\bar{b}\ell^+\ell^-$ ($\ell = e, \mu$), we discuss how new physics in the top Higgs sector that enhances the ZZ component can leave footprints in the HZ limit setting. In passing we investigate the phenomenology of a class of new physics interactions that can be genuinely studied in this process.

ELEMENTARY PARTICLES, FIELDS & NUCLEAR PHYSICS

A. S. Fenta

The ^{68m}Cu/^{68}Cu isotope as a new probe for hyperfine studies: The nuclear moments

A. S. Fenta, S. Pallada, J. G. Correia, M. Stachura, K. Johnston, A. Gottberg, A. Mokhles Gerami, J. Röder, H. Grawe, B. A. Brown, U. Köster, T. M. Mendonça, J. P. Ramos, B. A. Marsh, T. Day Goodacre, V. S. Amaral, L. M. C. Pereira, M.J.G. Borge and H. Haas

2016 *EPL* **115** 62002

Time Differential Perturbed Angular Correlation of γ-rays (TDPAC) experiments were performed for the first time in the decay of ^{68m}Cu (6^-, 721 keV, 3:75 min) produced at the ISOLDE facility at CERN. Due to the short half-life of the source isotope, the measurements were carried out online. The intermediate state (2^+, 84:1 keV, 7:84 ns) offers the unique opportunity to study the electromagnetic fields acting at a copper probe in condensed matter via hyperfine interactions. The present work allowed determination of the nuclear moments for this state. The electric quadrupole moment $|Q(2^+, 84{:}1\ \text{keV})| = 0.110(3)$ b was obtained from an experiment performed in Cu_2O and the magnetic dipole moment $|\mu| = 2.857(6)\ \mu_N$ from measurements in cobalt and nickel foils. The results are discussed in the framework of shell model calculations and the additivity rule for nuclear moments with respect to the robustness of the $N = 40$ sub-shell.

Takashi Yanagisawa

Chiral sine-Gordon model

Takashi Yanagisawa

2016 *EPL* **113** 41001

We investigate the chiral sine-Gordon model using the renormalization group method. The chiral sine-Gordon model is a model for *G*-valued fields and describes a new class of phase transitions, where *G* is a compact Lie group. We show that the model is renormalizable by means of a perturbation expansion and we derive beta functions of the renormalization group theory. The coefficients of beta functions are represented by the Casimir invariants. The model contains both asymptotically free and ultraviolet strong-coupling regions. The beta functions have a zero which is a bifurcation point that divides the parameter space into two regions; they are the weak-coupling region and the strong-coupling region. A large-*N* model is also considered. This model is reduced to the conventional sine-Gordon model that describes the Kosterlitz-Thouless transition near the fixed point. In the strong-coupling limit, the model is reduced to a *U(N)* matrix model.

ELEMENTARY PARTICLES, FIELDS & NUCLEAR PHYSICS


M. P. Silverman

Search for anomalies in the decay of radioactive Mn-54

M. P. Silverman

2016 *EPL* **114** 62001

Recent papers have reported that ^{54}Mn, which decays by electron capture (a weak nuclear interaction) with half-life ~312 days, is influenced by solar activity. Should this actually occur, new physics would be needed to explain it. This paper reports results of an analysis of ^{54}Mn activity measured over a time interval of ~3.6 half-lives. If standard nuclear physics applies, the logarithmic residuals of ^{54}Mn activities should form a stationary set of independent random variables whose statistics are determined solely by a constant decay rate λ and initial mean count μ. Analysis of the time-variation, autocorrelation, and power spectra of the ^{54}Mn logarithmic residuals agrees exquisitely with standard nuclear physics. Computer-simulated activities exhibiting periodic decay of amplitude $A = \alpha\lambda$ show that anomalies would be detectable by these statistical tests for values of α as low as ~1 part in 10^4. This limit is about 10 times lower than reported deviations from exponential decay.

Screening and resonance enhancements of the ^{2}H(d, p)^{3}H reaction yield in metallic environments

K. Czerski, D. Weissbach, A. I. Kilic, G. Ruprecht, A. Huke, M. Kaczmarski, N. Targosz-Ślęczka and K. Maass

2016 *EPL* **113** 22001

The ^{2}H(d, p)^{3}H reaction cross-section has been measured for deuteron energies below 25 keV in a deuterized Zr target under improved ultra-high-vacuum conditions and controlled target surface contamination. The increase of reaction enhancement factors towards lower energies is much weaker than that determined before and can result not only from the electron screening effect but also from a suggested 0^+ threshold resonance in ^{4}He. The cross-section calculations performed within the *T*-matrix approximation enable to estimate a coherent resonance contribution and explain the observed energy dependence of the enhancement factors. Additionally, indications for the increase of the screening energies due to impurities at the target surface could be found.

Atomic & molecular physics

Thickness-dependent nanofriction of a rare gas monolayer sliding on Pb(111) ultrathin films

X. L. Cai, J. J. Wang, X. N. Fu, S. Y. Bai, C. Y. Niu and Y. Jia

2016 *EPL* **113** 46002

The friction can be affected dramatically by quantum size effects (QSEs) and edge effects at nanoscale. The modulations of QSEs on nanofriction of a rare gas (RG) monolayer sliding on Pb(111) ultrathin films were investigated by using the first-principles approach within density functional theory (DFT) with van der Waals (vdW) interaction correction. Our findings revealed that there exist even-odd oscillations in the friction with the thickness of Pb(111) substrate and the friction can be tuned up to 30% by the different thicknesses of Pb(111) films. Moreover, such modulation is more obvious for the RG adatoms with larger radius. The underlying physics is that the oscillations of the electronic density of states at Fermi level induce different interactions and energy barriers between RG and Pb(111) films with different thicknesses. Overall, we here propose an approach to tune friction and a way to identify the electronic contribution to friction via the different thicknesses of substrates at nanoscale.

Electromagnetism, optics, quantum optics, acoustics, heat transfer & classical mechanics

PERSPECTIVE

Victor Malka

Manipulating relativistic electrons with lasers

Victor Malka

2016 *EPL* **115** 54001

The motion control of relativistic electrons with lasers allows for an efficient and elegant way to map the space with ultra-intense electric-field components, which, in turn, permits a unique improvement of the electron beam parameters. This perspective addresses the recent laser plasma accelerator experiments related to the phase space engineering of electron beams in a plasma medium performed at LOA.

OPEN ACCESS

Scaling of shear-induced diffusion and clustering in a blood-like suspension

L. Mountrakis, E. Lorenz and A. G. Hoekstra

2016 *EPL* **114** 14002

The transport of cells and substances in dense suspensions like blood heavily depends on the microstructure and the dynamics arising from their interactions with red blood cells (RBCs). Computer simulations are used to probe into the detailed transport-related characteristics of a blood-like suspension, for a wide range of volume fractions and shear rates. The shear-induced diffusion of RBCs does not follow the established linear scaling with shear rate for higher volume fractions. The properties directly related to RBC deformability —stretching and flow orientation— are not sufficient to explain this departure according to the model of Breedveld, pointing to the dominance of collective effects in the suspension. A cluster size analysis confirms that collective effects dominate high volume fractions, as the mean cluster size is above 2 and the number of "free RBCs" is significantly decreased in denser suspensions. The mean duration of RBC contacts in clusters is increased in the high volume fraction and shear rate cases, showing that these clusters live longer.

ELECTROMAGNETISM, OPTICS, QUANTUM OPTICS, ACOUSTICS, HEAT TRANSFER & CLASSICAL MECHANICS

OPEN ACCESS

J. Borburgh

First implementation of transversely split proton beams in the CERN Proton Synchrotron for the fixed-target physics programme

J. Borburgh, S. Damjanovic, S. Gilardoni, M. Giovannozzi, C. Hernalsteens, M. Hourican, A. Huschauer, K. Kahle, G. Le Godec, O. Michels and G. Sterbini

2016 *EPL* **113** 34001

A new extraction technique has been studied at the CERN Proton Synchrotron with a view of using it for the fixed-target physics programme at the Super Proton Synchrotron. The extraction scheme is based on advanced concepts of non-linear beam dynamics: prior to extraction a particle beam is split into several beamlets in a transverse plane by crossing a stable resonance, which allows extracting the beamlets over multiple turns. The principle of the extraction, the implementation detail and the progress of beam commissioning over the years are discussed.

Eyal Buks

Sensing dispersive and dissipative forces by an optomechanical cavity

Oren Suchoi and Eyal Buks

2016 *EPL* **115** 14001

We experimentally study an optomechanical cavity formed between a mechanical resonator, which serves as a movable mirror, and a stationary on-fiber dielectric mirror. A significant change in the behavior of the system is observed when the distance between the fiber's tip and the mechanical resonator is made smaller than about 1 μm. The combined influence of Casimir force, Coulomb interaction due to trapped charges and optomechanical coupling is theoretically analyzed. The comparison between experimental results and theory yields a partial agreement.

C. Dubois

Between inertia and viscous effects: Sliding bubbles beneath an inclined plane

C. Dubois, A. Duchesne and H. Caps

2016 *EPL* **115** 44001

The ascent motion of an air bubble beneath an inclined plane is experimentally studied. The effects of the surrounding liquid viscosity and surface tension, the bubble radius and the tilt angle are investigated. A dynamical model is proposed. It opposes the buoyant driving force to the hydrodynamical pressure arising from the bubble motion and the capillary meniscus generated in front of the bubble in order to create a lubrication film between the bubble and the plate.

ELECTROMAGNETISM, OPTICS, QUANTUM OPTICS, ACOUSTICS, HEAT TRANSFER & CLASSICAL MECHANICS

Can dielectric spheres accurately model atomic scale interactions?

O. I. Obolensky, T. P. Doerr, A. Y. Ogurtsov and Yi-Kuo Yu

2016 *EPL* **116** 24003

We calculate the polarization portion of electrostatic interactions at the atomic scale using quantum mechanical methods such as density functional theories (FT) and the coupled cluster approach, and using classical methods such as a surface charge method and a polarizable force field. The agreement among various methods is investigated. Using the coupled clusters method CCSD(T) with large basis sets as the reference, we find that for systems comprising two to six atoms and ions in S-states the classical surface charge method performs much better than commonly used DFT methods with moderate basis sets such as B3LYP/6-31G(d,p). The remarkable performance of the classical approach comes as a surprise. The present results indicate that the use of a rigorous formalism of classical electrostatics can be better justified for determining molecular interactions at intermediate distances than some of the widely used methods of quantum chemistry.

Meredith Cox

Robert P. Behringer

Self-organized magnetic particles to tune the mechanical behavior of a granular system

Meredith Cox, Dong Wang, Jonathan Barés and Robert P. Behringer

2016 *EPL* **115** 64003

Above a certain density a granular material jams. This property can be controlled by either tuning a global property, such as the packing fraction or by applying shear strain, or at the micro-scale by tuning grain shape, inter-particle friction or externally controlled organization. Here, we introduce a novel way to change a local granular property by adding a weak anisotropic magnetic interaction between particles. We measure the evolution of the pressure, P, and coordination number, Z, for a packing of 2D photo-elastic disks, subject to uniaxial compression. A fraction R_m of the particles have embedded cuboidal magnets. The strength of the magnetic interactions between particles is too weak to have a strong direct effect on P or Z when the system is jammed. However, the magnetic interactions play an important role in the evolution of latent force networks when systems containing a large enough fraction of the particles with magnets are driven through unjammed to jammed states. In this case, a statistically stable network of magnetic chains self-organizes before jamming and overlaps with force chains once jamming occurs, strengthening the granular medium. This property opens a novel way to control mechanical properties of granular materials.

Physics of gases, plasmas & fusion

PERSPECTIVE

Dimitri Batani

Matter in extreme conditions produced by lasers

Dimitri Batani

2016 *EPL* **114** 65001

This perspective addresses the study of “extreme” states of matter created by laser pulses. We define “warm dense states” and “high energy density”, their importance in physics, how to produce and diagnose them, either using isochoric heating with short-pulse lasers or laser-driven shock waves.

Dimitri Batani

Generation and characterization of warm dense matter isochorically heated by laser-induced relativistic electrons in a wire target

A. Schönlein, G. Boutoux, S. Pikuz, L. Antonelli, D. Batani, A. Debayle, A. Franz, L. Giuffrida, J. J. Honrubia, J. Jacoby, D. Khaghani, P. Neumayer, O. N. Rosmej, T. Sakaki, J. J. Santos and A. Sauteray

2016 *EPL* **114** 45002

We studied the interaction of a high-intensity laser with mass-limited Ti-wires. The laser was focused up to 7×10^{20} W/cm^2, with contrast of 10^{-10} to produce relativistic electrons. High-spatial-resolution X-ray spectroscopy was used to measure isochoric heating induced by hot electrons propagating along the wire up to 1 mm depth. For the first time it was possible to distinguish surface target regions heated by mixed plasma mechanisms from those heated only by the hot electrons that generate warm dense matter with temperatures up to 50 eV. Our results are compared to simulations that highlight both the role of electron confinement inside the wire and the importance of resistive stopping powers in warm dense matter.

Experimental investigations of strongly coupled Coulomb systems of diamagnetic dust particles in a magnetic trap under microgravity conditions

T. S. Ramazanov, L. G. D'yachkov, K. N. Dzhumagulova, M. T. Gabdullin, M. K. Dosbolayev, Y. A. Ussenov, Zh. A. Moldabekov, O. F. Petrov, M. M. Vasiliev, M. I. Myasnikov, V. E. Fortov, S. F. Savin, T. A. Musabayev, Zh. Sh. Zhantayev and A. A. Aimbetov

2016 *EPL* **116** 45001

A series of experiments on the modernized “Coulomb crystals” setup on board of the International Space Station (ISS) was performed. Formation of a cluster of charged and uncharged particles was observed. Excitation and damping of cluster oscillations, as well as its destruction in the high electric field were investigated. Charges of the particles were evaluated on the basis of their rate of expansion from the cluster. Some conclusions about the cluster structure have been presented.

M. Kh. Gadzhiev

One more study of argon arc binding to pure tungsten cathode

M. Kh. Gadzhiev, M. A. Sargsyan, D. V. Tereshonok and A. S. Tyuftyaev

2016 *EPL* **115** 35002

Pyrometric and spectroscopic investigations of pure tungsten cathode in argon arc plasma discharge at atmospheric pressure are reported. The distribution of surface cathode temperature and the radial distribution of plasma temperature at different distance from the cathode tip were measured. We conducted a comparison between our work and other studies on arc discharges where cathodes from lanthanated (W-2% La_2O_3) and thoriated (W-2% ThO_2) tungsten were used.

Forced mode coupling in 2D complex plasmas

L. Couëdel, T. B. Röcker, S. K. Zhdanov, V. Nosenko, H. M. Thomas and A. V. Ivlev

2016 *EPL* **115** 45002

It is demonstrated experimentally that the plasma-wake–mediated resonant coupling of the longitudinal in-plane and out-of-plane collective motion in two-dimensional plasma crystals can be induced by applying an external forcing. The experimental observations are supported by numerical analysis of the forced collective dynamics of particles with the wake-mediated interactions.

Condensed matter: structural, mechanical & thermal properties

PERSPECTIVE

Bruno Andreotti

Jacco H. Snoeijer

Soft wetting and the Shuttleworth effect, at the crossroads between thermodynamics and mechanics

Bruno Andreotti and Jacco H. Snoeijer

2016 *EPL* **113** 66001

Extremely compliant elastic materials, such as thin membranes or soft gels, can be deformed when wetted by a liquid drop. It is commonly assumed that the solid capillarity in “soft wetting” can be treated in the same manner as liquid surface tension. However, the physical chemistry of a solid interface is itself affected by any distortion with respect to the elastic reference state. This gives rise to phenomena that have no counterpart in liquids: the mechanical surface stress is different from the excess free energy in surface. Here we point out some striking consequences of this “Shuttleworth effect” in the context of wetting on deformable substrates, such as the appearance of elastic singularities and unconventional capillary forces. We provide a synthesis between different viewpoints on soft wetting (microscopic and macroscopic, mechanics and thermodynamics), and point out key open issues in the field.

OPEN ACCESS

Tomasz Sowiński

Diffusion in a system of a few distinguishable fermions in a one-dimensional double-well potential

Tomasz Sowiński, Mariusz Gajda and Kazimierz Rzażewski

2016 *EPL* **113** 56003

Dynamical properties of a few ultra-cold fermions confined in a double-well potential are studied. We show that the dynamics, which is governed by single-particle tunnelings for vanishing interactions, is completely different for strong interactions. Depending on the details of the configuration, for sufficiently strong interactions (repulsions or attractions) the particle flow through the barrier can be accelerated or slowed down. This effect cannot be explained with the single-particle picture. It is clarified with a direct inspection of the spectrum of the few-body Hamiltonian.

CONDENSED MATTER: STRUCTURAL, MECHANICAL & THERMAL PROPERTIES

OPEN ACCESS

Rafał Ołdziejewski

Two dipolar atoms in a harmonic trap

Rafał Ołdziejewski, Wojciech Górecki and Kazimierz Rzążewski

2016 *EPL* **114** 46003

Two identical dipolar atoms moving in a harmonic trap without an external magnetic field are investigated. Using the algebra of angular momentum we reduce the problem to a simple numerics. We show that the internal spin-spin interactions between the atoms couple to the orbital angular momentum causing an analogue of the Einstein-de Haas effect. We show a possibility of adiabatically pumping our system from the *s*-wave to the *d*-wave relative motion. The effective spin-orbit coupling occurs at anti-crossings of the energy levels.

OPEN ACCESS

Priyanka

Critical dynamics of classical systems under slow quench

Priyanka and Kavita Jain

2016 *EPL* **116** 26003

We study the slow quench dynamics of a one-dimensional non equilibrium lattice gas model which exhibits a phase transition in the stationary state between a fluid phase with homogeneously distributed particles and a jammed phase with a macroscopic hole cluster. Our main result is that in the critical region (i.e., at the critical point and in its vicinity) where the dynamics are assumed to be frozen in the standard Kibble-Zurek argument, the defect density exhibits an algebraic decay in the inverse annealing rate with an exponent that can be understood using critical coarsening dynamics. However, in a part of the critical region in the fluid phase, the standard Kibble-Zurek scaling holds. We also find that when the slow quench occurs deep into the jammed phase, the defect density behavior is explained by the rapid quench dynamics in this phase.

CONDENSED MATTER: STRUCTURAL, MECHANICAL & THERMAL PROPERTIES

Olaf Stenull

First-order phase transitions in outbreaks of co-infectious diseases and the extended general epidemic process

Hans-Karl Janssen and Olaf Stenull

2016 *EPL* **113** 26005

In co-infections, positive feedback between multiple diseases can accelerate outbreaks. In a recent letter Chen, Ghanbarnejad, Cai, and Grassberger (CGCG) introduced a spatially homogeneous mean-field model system for such co-infections, and studied this system numerically with focus on the possible existence of discontinuous phase transitions. We show that their model coincides in mean-field theory with the homogenous limit of the extended general epidemic process (EGEP). Studying the latter analytically, we argue that the discontinuous transition observed by CGCG is basically a spinodal phase transition and not a first-order transition with phase coexistence. We derive the conditions for this spinodal transition along with predictions for important quantities such as the magnitude of the discontinuity. We also shed light on a true first-order transition with phase coexistence by discussing the EGEP with spatial inhomogeneities.

The effect of spatiality on multiplex networks

Michael M. Danziger, Louis M. Shekhtman, Yehiel Berezin and Shlomo Havlin

2016 *EPL* **115** 36002

Many multiplex networks are embedded in space, with links more likely to exist between nearby nodes than distant nodes. For example, interdependent infrastructure networks can be represented as multiplex networks, where each layer has links among nearby nodes. Here, we model the effect of spatiality on the robustness of a multiplex network embedded in 2-dimensional space, where links in each layer are of variable but constrained length. Based on empirical measurements of real-world networks, we adopt exponentially distributed link lengths with characteristic length ζ. By changing ζ, we modulate the strength of the spatial embedding. When $\zeta \to \infty$, all link lengths are equally likely, and the spatiality does not affect the topology. However, when $\zeta \to 0$ only short links are allowed, and the topology is overwhelmingly determined by the spatial embedding. We find that, though longer links strengthen a single-layer network, they make a multi-layer network more vulnerable. We further find that when ζ is longer than a certain critical value, ζ_c, abrupt, discontinuous transitions take place, while for $\zeta < \zeta_c$ the transition is continuous, indicating that the risk of abrupt collapse can be eliminated if the typical link length is shorter than ζ_c.

CONDENSED MATTER: STRUCTURAL, MECHANICAL & THERMAL PROPERTIES

M. İşeri

Depinning as a coagulation process

M. İşeri, D. Kaspar and M. Mungan

2016 *EPL* **115** 46003

We consider a one-dimensional model that describes the depinning of an elastic string of particles in a strongly pinning, phase-disordered periodic environment under a slowly increasing force. The evolution towards depinning occurs by the triggering of avalanches in regions of activity which are at first isolated, but later grow and merge. For large system sizes the dynamically critical behavior is dominated by the coagulation of these active regions. Our analysis and numerical simulations show that the evolution of the sizes of active regions is well described by a Smoluchowski coagulation equation, allowing us to predict correlation lengths and avalanche sizes in terms of certain moments of the size distribution.

Yevgeny Bar Lev

David R. Reichman

Slow dynamics in a two-dimensional Anderson-Hubbard model

Yevgeny Bar Lev and David R. Reichman

2016 *EPL* **113** 46001

We study the real-time dynamics of a two-dimensional Anderson-Hubbard model using nonequilibrium self-consistent perturbation theory within the second-Born approximation. When compared with exact diagonalization performed on small clusters, we demonstrate that for strong disorder this technique approaches the exact result on all available timescales, while for intermediate disorder, in the vicinity of the many-body localization transition, it produces quantitatively accurate results up to nontrivial times. Our method allows for the treatment of system sizes inaccessible by any numerically exact method and for the complete elimination of finite-size effects for the times considered. We show that for a sufficiently strong disorder the system becomes nonergodic, while for intermediate disorder strengths and for all accessible timescales transport in the system is strictly subdiffusive. We argue that these results are incompatible with a simple percolation picture, but are consistent with the heuristic random resistor network model where subdiffusion may be observed for long times until a crossover to diffusion occurs. The prediction of slow finite-time dynamics in a two-dimensional interacting and disordered system can be directly verified in future cold-atoms experiments.

CONDENSED MATTER: STRUCTURAL, MECHANICAL & THERMAL PROPERTIES

Analog simulation of Weyl particles with cold atoms

Daniel Suchet, Mihail Rabinovic, Thomas Reimann, Norman Kretschmar, Franz Sievers, Christophe Salomon, Johnathan Lau, Olga Goulko, Carlos Lobo and Frédéric Chevy

2016 *EPL* **114** 26005

In this letter we report on a novel approach to study the dynamics of harmonically confined Weyl particles using magnetically trapped fermionic atoms. We find that after a kick of its center of mass, the system relaxes towards a steady state even in the absence of interactions, in stark contrast with massive particles which would oscillate without damping. Remarkably, the equilibrium distribution is non-Boltzmann, exhibiting a strong anisotropy which we study both numerically and experimentally.

C. Raufaste

Reactive Leidenfrost droplets

C. Raufaste, Y. Bouret and F. Celestini

2016 *EPL* **114** 46005

We experimentally investigate the reactivity of Leidenfrost droplets with their supporting substrates. Several organic liquids are put into contact with a copper substrate heated above their Leidenfrost temperature. As the liquid evaporates, the gaseous flow cleans the superficial copper oxide formed at the substrate surface and the reaction maintains a native copper spot below the evaporating droplet. This study shows an interesting coupling between the physics of the Leidenfrost effect and the mechanics of reactive flows.

Appala Naidu Gandi

Thermal conductivity of bulk and monolayer MoS_2

Appala Naidu Gandi and Udo Schwingenschlögl

2016 *EPL* **113** 36002

We show that the lattice contribution to the thermal conductivity of MoS_2 strongly dominates the carrier contribution in a broad temperature range from 300 to 800 K. Since theoretical insight into the lattice contribution is largely missing, though it would be essential for materials design, we solve the Boltzmann transport equation for the phonons self-consistently in order to evaluate the phonon lifetimes. The low out-of-plane thermal conductivity of bulk MoS_2 (2.3 $Wm^{-1}K^{-1}$ at 300 K) is useful for thermoelectric applications. The thermal conductivity of monolayer MoS_2 (131 $Wm^{-1}K^{-1}$ at 300 K) is comparable to that of Si.

O. M. Braun

B. N. J. Persson

On the dependency of friction on load: Theory and experiment

O. M. Braun, B. Steenwyk, A. Warhadpande and B. N. J. Persson

2016 *EPL* **113** 56002

In rubber friction studies it is often observed that the kinetic friction coefficient depends on the nominal contact pressure. This is usually due to frictional heating, which softens the rubber, increases the area of contact, and (in most cases) reduces the viscoelastic contribution to the friction. In this paper we present experimental results showing that the rubber friction also depends on the nominal contact pressure at such low sliding speed that frictional heating is negligible. This effect has important implications for rubber sliding dynamics, e.g., in the context of the tire-road grip. We attribute this effect to the viscoelastic coupling between the macroasperity contact regions, and present a simple earthquake-like model and numerical simulations supporting this picture. The mechanism for the dependency of the friction coefficient on the load considered is very general, and is relevant for non-rubber materials as well.

Polaron character of the near-E_F band of cleaved $In_2O_3(111)$ single crystals

Valentina Scherer, Christoph Janowitz, Zbigniew Galazka, Maryam Nazarzadehmoafi and Recardo Manzke

2016 *EPL* **113** 26003

The near-E_F band of the *in situ* cleaved (111) surface of high-quality *n*-type In_2O_3 single crystals was investigated by high-resolution angle-resolved photoemission (ARPES) along the major symmetry lines of the three-dimensional Brillouin zone. Several criteria to pin down Fermi level crossings and Fermi momenta were applied. The near-E_F band is of three-dimensional character connected to the bottom of the conduction band. Since the model of a degenerate semiconductor due to high *n*-type doping ($n = 1.8 \times 10^{18}$ cm^{-3}) is not sufficient the interaction of electron and phonon degrees of freedom is discussed. It is found that the model of Landau-Pekar polarons is capable of describing the observed lineshape qualitatively and the bandwidth of the occupied part of the conduction band quantitatively.

Condensed matter: electronic structure, electrical, magnetic & optical properties

PERSPECTIVE

Ultrafast angle-resolved photoemission spectroscopy of quantum materials

Christopher L. Smallwood, Robert A. Kaindl and Alessandra Lanzara

2016 *EPL* **115** 27001

Techniques in time- and angle-resolved photoemission spectroscopy have facilitated a number of recent advances in the study of quantum materials. We review developments in this field related to the study of incoherent nonequilibrium electron dynamics, the analysis of interactions between electrons and collective excitations, the exploration of dressed-state physics, and the illumination of unoccupied band structure. Future prospects are also discussed.

OPEN ACCESS

L. J. Collins-McIntyre

T. Hesjedal

Structural, electronic, and magnetic investigation of magnetic ordering in MBE-grown $Cr_xSb_{2-x}Te_3$ thin films

L. J. Collins-McIntyre, L. B. Duffy, A. Singh, N.-J. Steinke, C. J. Kinane, T. R. Charlton, A. Pushp, A. J. Kellock, S. S. P. Parkin, S. N. Holmes, C. H. W. Barnes, G. van der Laan, S. Langridge and T. Hesjedal

2016 *EPL* **115** 27006

We report the structural, electronic, and magnetic study of Cr-doped Sb_2Te_3 thin films grown by a two-step deposition process using molecular-beam epitaxy (MBE). The samples were investigated using a variety of complementary techniques, namely, x-ray diffraction (XRD), atomic force microscopy, SQUID magnetometry, magneto-transport, and polarized neutron reflectometry (PNR). It is found that the samples retain good crystalline order up to a doping level of $x = 0.42$ (in $Cr_x Sb_{2-x}Te_3$), above which degradation of the crystal structure is observed by XRD. Fits to the recorded XRD spectra indicate a general reduction in the c-axis lattice parameter as a function of doping, consistent with substitutional doping with an ion of smaller ionic radius. The samples show soft ferromagnetic behavior with the easy axis of magnetization being out-of-plane. The saturation magnetization is dependent on the doping level, and reaches from $\sim 2\,\mu_B$ to almost $3\,\mu_B$ per Cr ion. The transition temperature (T_c) depends strongly on the Cr concentration and is found to increase with doping concentration. Electric transport measurements find surface-dominated transport below ~ 10 K. The magnetic properties extracted from anomalous Hall effect data are in excellent agreement with the magnetometry data.

Pere Alemany

Charge transfer and $2k_F$ vs. $4k_F$ instabilities in the NMP-TCNQ molecular metal and $(NMP)_x(Phen)_{1-x}$TCNQ solid solutions

Pere Alemany, Enric Canadell and Jean-Paul Pouget

2016 *EPL* **113** 27006

A first-principles DFT study of the electronic structure of the two-chain molecular conductor NMP-TCNQ is reported. It is shown that the charge transfer occurring in this salt is not 1 but 2/3, finally settling the debate concerning the real charge transfer in this molecular metal. These calculations also lead to a simple rationalization of the three different regimes of $2k_F$ and $4k_F$ CDW instabilities occurring in the solid solutions $(NMP)_x(Phen)_{1-x}$TCNQ.

N. Traverso Ziani

Charge and spin density in the helical Luttinger liquid

N. Traverso Ziani, C. Fleckenstein, F. Crépin and B. Trauzettel

2016 *EPL* **113** 37002

The weakly interacting helical Luttinger liquid, due to spin momentum locking, is characterized by extremely peculiar local observables: we show that the density-density correlation functions do not exhibit signatures of Friedel and Wigner oscillations, and that spin-spin correlation functions, which are strongly anisotropic, witness the formation of a planar spin wave. Moreover, we demonstrate that the most relevant scattering potentials involving a localized impurity are not able to modify the electron density, while only magnetic impurities can pin the planar spin density wave.

Topological phase transitions in the 1D multichannel Dirac equation with random mass and a random matrix model

Aurélien Grabsch and Christophe Texier

2016 *EPL* **116** 17004

We establish the connection between a multichannel disordered model—the 1D Dirac equation with $N \times N$ matrix random mass—and a random matrix model corresponding to a deformation of the Laguerre ensemble. This allows us to derive exact determinantal representations for the density of states and identify its low energy ($\varepsilon \to 0$) behaviour $\rho(\varepsilon) \sim |\varepsilon|^{\alpha-1}$. The vanishing of the exponent α for N specific values of the averaged mass over disorder ratio corresponds to N phase transitions of topological nature characterised by the change of a quantum number (Witten index) which is deduced straightforwardly in the matrix model.

CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC & OPTICAL PROPERTIES

Strongly coupled fixed point in ϕ^4 theory

Anthony Hegg and Philip W. Phillips

2016 *EPL* **115** 27005

We show explicitly how a fixed point can be constructed in scalar $g\phi^4$ theory from the solutions to a nonlinear eigenvalue problem. The fixed point is unstable and characterized by $\nu = 2/d$ (correlation length exponent), $\eta = ½ - d/8$ (anomalous dimension). For $d = 2$, these exponents reproduce to those of the Ising model which can be understood from the codimension of the critical point. The testable prediction of this fixed point is that the specific heat exponent vanishes. 2d critical Mott systems are well described by this new fixed point.

N. P. Ong

Anomalous conductivity tensor in the Dirac semimetal Na_3Bi

Jun Xiong, Satya Kushwaha, Jason Krizan, Tian Liang, R. J. Cava and N. P. Ong

2016 *EPL* **114** 27002

Na_3Bi is a Dirac semimetal with protected nodes that may be sensitive to the breaking of time-reversal invariance in a magnetic field **B**. We report experiments which reveal that both the conductivity and resistivity tensors exhibit robust anomalies in B. The resistivity ρ_{xx} is B-linear up to 35 T, while the Hall angle exhibits an unusual profile approaching a step function. The conductivities σ_{xx} and σ_{xy} share identical power-law dependences at large B. We propose that these significant deviations from conventional transport result from an unusual sensitivity of the transport lifetime to B. The transport features are compared with those in Cd_3As_2.

D. Chevallier

Probing Majorana and Andreev bound states with waiting times

D. Chevallier, M. Albert and P. Devillard

2016 *EPL* **116** 27005

We consider a biased Normal-Superconducting junction with various types of superconductivity. Depending on the class of superconductivity, a Majorana bound state may appear at the interface. We show that this has important consequences on the statistical distribution of time delays between detection of consecutive electrons flowing out of such an interface, namely the waiting time distribution. Therefore, this quantity is shown to be a clear fingerprint of Majorana bound state physics and may be considered as an experimental signature of its presence.

Infrared light emission from nano hot electron gas created in atomic point contacts

T. Malinowski, H. R. Klein, M. Iazykov and Ph. Dumas

2016 *EPL* **114** 57002

Gold atomic point contacts are prototype systems to evidence ballistic electron transport. The typical dimension of the nanojunction being smaller than the electron-phonon interaction length, even at room temperature, electrons transfer their excess energy to the lattice only far from the contact. At the contact however, favored by huge current densities, electron–electron interactions result in a nano hot electron gas acting as a source of photons. Using a home built Mechanically Controlled Break Junction, it is reported here, for the first time, that this nano hot electron gas also radiates in the infrared range (0.2 eV to 1.2 eV). Moreover, following the description introduced by Tomchuk *et al.* (*Sov. Phys.-Solid State*, **8** (1966) 2510), we show that this radiation is compatible with a black-body-like spectrum emitted from an electron gas at temperatures of several thousands of kelvins.

The electromagnetic response of a relativistic Fermi gas at finite temperatures: Applications to condensed-matter systems

E. Reyes-Gómez, L. E. Oliveira and C. A. A. de Carvalho

2016 *EPL* **114** 17009

We investigate the electromagnetic response of a relativistic Fermi gas at finite temperatures. Our theoretical results are first-order in the fine-structure constant. The electromagnetic permittivity and permeability are introduced via general constitutive relations in reciprocal space, and computed for different values of the gas density and temperature. As expected, the electric permittivity of the relativistic Fermi gas is found in good agreement with the Lindhard dielectric function in the low-temperature limit. Applications to condensed-matter physics are briefly discussed. In particular, theoretical results are in good agreement with experimental measurements of the plasmon energy in graphite and tin oxide, as functions of both the temperature and wave vector. We stress that the present electromagnetic response of a relativistic Fermi gas at finite temperatures could be of potential interest in future plasmonic and photonic investigations.

CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC & OPTICAL PROPERTIES

Sweety Deswal

Ashish Jain

Conduction and switching mechanism in Nb_2O_5 thin films based resistive switches

Sweety Deswal, Ashish Jain, Hitesh Borkar, Ashok Kumar and Ajeet Kumar

2016 *EPL* **116** 17003

We report unipolar resistive switching of $Pt/Nb_2O_5/Al$ device with orthorhombic crystalline phase prepared by reactive sputtering method. It showed non-volatile reproducible unipolar switching with ON/OFF resistance ratio of 10^3 or higher. The range of SET and RESET voltage was 1.0–2.0 V and 0.3–0.8 V, respectively, depending on devices and their dimension. The charge carriers followed ohmic and space charge limited conduction (SCLC) behaviour in low resistance state (LRS) and high resistance state (HRS) states, respectively. An impedance spectroscopy analysis as well as a drift and diffusion of oxygen ion vacancy model are presented to explain the conducting filament formation and its rupture during the SET and RESET processes.

Pavel A. Andreev

Separated spin-up and spin-down evolution of degenerated electrons in two-dimensional systems: Dispersion of longitudinal collective excitations in plane and nanotube geometry

Pavel A. Andreev and L. S. Kuz'menkov

2016 *EPL* **113** 17001

Applying the separated spin evolution quantum hydrodynamics to the two-dimensional electron gas in plane samples and nanotubes located in external magnetic fields we have found a novel type of waves in the electron gas which is called spin-electron acoustic wave. A separate spin-up and spin-down electrons' evolution reveals the replacement of the Langmuir wave by a pair of hybrid waves. One of the two hybrid waves is a modified Langmuir wave. Another hybrid wave is a spin-electron acoustic wave. We studied the dispersion of these waves in two-dimensional structures of electrons. We also considered the dependence of dispersion properties on spin polarization of electrons in an external magnetic field.

Zhi-An Ren

Superconductivity at 3.85 K in $BaPd_2As_2$ with the $ThCr_2Si_2$-type structure

Qi Guo, Jia Yu, Bin-Bin Ruan, Dong-Yun Chen, Xiao-Chuan Wang, Qing-Ge Mu, Bo-Jin Pan, Gen-Fu Chen and Zhi-An Ren

2016 *EPL* **113** 17002

The single crystal of $ThCr_2Si_2$-type $BaPd_2As_2$ was successfully prepared by a self-flux method, and the crystal structure was characterized by X-ray diffraction method with the lattice parameters a = 4.489(2) Å and c = 10.322(3) Å (space group *I*4/*mmm*, No. 139). Bulk superconductivity below a T_c (critical temperature) of 3.85 K was revealed in this compound by the measurements of resistivity, magnetic susceptibility and specific heat, and this T_c is much higher than those of other isostructural Pd-based superconductors.

Satyendra Nath Gupta

A. K. Sood

Raman signatures of strong Kitaev exchange correlations in $(Na_{1-x}Li_x)_2IrO_3$: Experiments and theory

Satyendra Nath Gupta, P. V. Sriluckshmy, Kavita Mehlawat, Ashiwini Balodhi, Dileep K. Mishra, S. R. Hassan, T. V. Ramakrishnan, D. V. S. Muthu, Yogesh Singh and A. K. Sood

2016 *EPL* **114** 47004

Inelastic light scattering studies on single crystals of $(Na_{1-x}Li_x)_2IrO_3$ (x = 0, 0.05 and 0.15) show a polarization-independent broad band at ~2750 cm^{-1} with a large bandwidth ~1800 cm^{-1}. For Na_2IrO_3 the broad band is seen for temperatures ≤ 200 K and persists inside the magnetically ordered state. For Li samples, the intensity of this mode increases, shifts to lower wave numbers, and persists to higher temperatures. Such a mode has recently been predicted (by Knolle *et al.*) as a signature of the Kitaev spin liquid. We assign the observation of the broad band to be a signature of strong Kitaev exchange correlations. The fact that the broad band persists even inside the magnetically ordered state suggests that dynamically fluctuating moments survive even below T_N. This is further supported by our mean-field calculations. The Raman response calculated in mean-field theory shows that the broad band predicted for the SL state survives in the magnetically ordered state near the zigzag-spin liquid phase boundary. A comparison with the theoretical model gives an estimate of the Kitaev exchange interaction parameter to be $J_K \approx 57$ meV.

CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC & OPTICAL PROPERTIES

Jinghui Gao

Xiaoqin Ke

Phase transition behaviours near the triple point for Pb-free (1−x) $Ba(Zr_{0.2}Ti_{0.8})O3{-}x(Ba_{0.7}Ca_{0.3})TiO_3$ piezoceramics

Jinghui Gao, Ye Dai, Xinghao Hu, Xiaoqin Ke, Lisheng Zhong, Shengtao Li, Lixue Zhang, Yu Wang, Dong Wang, Yan Wang, Yongbin Liu, Hu Xiao and Xiaobing Ren

2016 *EPL* **115** 37001

The reason for the large electromechanical response in Pb-free piezoceramic $Ba(Zr_{0.2}Ti_{0.8})O_3{-}(Ba_{0.7}Ca_{0.3})TiO_3$ (BZT-BCT) still remains controversial, and a central issue is whether or not the multi-phase-coexisting point (triple point) in the phase diagram is a thermodynamic tricritical point. In this letter, we study the phase transition behaviour for the ferro-para transitions of BZT-BCT specimens in the vicinity of a triple point. Our results show that latent heat and thermal hysteresis approach zero, while the permittivity peak value is maximized close to the triple-point composition, which suggests that the triple point exhibits nearly tricritical transition behaviours in the BZT-BCT system. Further, the TEM result shows that the domain width is minimized with composition approaching the triple point, which indicates a reduction of the domain wall energy possibly relevant to the tricriticality of the triple point. A sixth-order Landau energy modeling shows that the triple tricritical point provides a free-energy state of near-vanishing polarization anisotropy and thus enhances the piezoelectric response for such a material system.

J. Fink

Influence of Lifshitz transitions and correlation effects on the scattering rates of the charge carriers in iron-based superconductors

J. Fink

2016 *EPL* **113** 27002

Minimum model calculations on the co-action of hole vanishing Lifshitz transitions and correlation effects in ferropnictides are presented. The calculations predict non-Fermi-liquid behaviour and huge mass enhancements of the charge carriers at the Fermi level. The findings are compared with recent ARPES experiments and with measurements of transport and thermal properties of ferropnictides. The results from the calculation can be also applied to other unconventional superconductors and question the traditional view of quantum-critical points.

Applied & interdisciplinary topics

PERSPECTIVE

R. A. Oliver

Nitride quantum light sources

T. Zhu and R. A. Oliver

2016 *EPL* **113** 38001

Prototype nitride quantum light sources, particularly single-photon emitters, have been successfully demonstrated, despite the challenges inherent in this complex materials system. The large band offsets available between different nitride alloys have allowed device operation at easily accessible temperatures. A wide range of approaches has been explored: not only self-assembled quantum dot growth but also lithographic methods for site-controlled nanostructure formation. All these approaches face common challenges, particularly strong background signals which contaminate the single-photon stream and excessive spectral diffusion of the quantum dot emission wavelength. If these challenges can be successfully overcome, then ongoing rapid progress in the conventional III-V semiconductors provides a roadmap for future progress in the nitrides.

OPEN ACCESS

Coordination number statistics of cluster formation

Colin P. Reynolds, David Robinson, Dirk G. A. L. Aarts, Mark Wilson, William W. Sampson and Roel P. A. Dullens

2016 *EPL* **116** 28001

We establish a direct relation between the distribution of coordination numbers for individual particles and the mean cluster size using simple statistical considerations. We test our probabilistic theory against an experimental model system of superparamagnetic colloidal particles, which form chain-like clusters upon the application of an external magnetic field. We find that the experimental cluster size distribution is well described by a shifted geometric distribution, consistent with a Smoluchowski aggregation scheme. Computer simulations of an atomistic model show that ordering of the positions of the particles prior to aggregation alters the cluster size distribution. These simulations corroborate the validity of our coordination number statistics approach to aggregation processes and demonstrate that the cluster formation process can be interpreted as a compound Poisson process.

APPLIED & INTERDISCIPLINARY TOPICS

OPEN ACCESS


Ginestra Bianconi

Functional Multiplex PageRank

Jacopo Iacovacci, Christoph Rahmede, Alex Arenas and Ginestra Bianconi

2016 *EPL* **116** 28004

Recently it has been recognized that many complex social, technological and biological networks have a multilayer nature and can be described by multiplex networks. Multiplex networks are formed by a set of nodes connected by links having different connotations forming the different layers of the multiplex. Characterizing the centrality of the nodes in a multiplex network is a challenging task since the centrality of the node naturally depends on the importance associated to links of a certain type. Here we propose to assign to each node of a multiplex network a centrality called Functional Multiplex PageRank that is a function of the weights given to every different pattern of connections (multilinks) existent in the multiplex network between any two nodes. Since multilinks distinguish all the possible ways in which the links in different layers can overlap, the Functional Multiplex PageRank can describe important non-linear effects when large relevance or small relevance is assigned to multilinks with overlap. Here we apply the Functional Page Rank to the multiplex airport networks, to the neuronal network of the nematode *C. elegans*, and to social collaboration and citation networks between scientists. This analysis reveals important differences existing between the most central nodes of these networks, and the correlations between their so called *pattern to success*.


Istvan Bikit


Dezső Varga

Novel approach to imaging by cosmic-ray muons

Istvan Bikit, Dusan Mrdja, Kristina Bikit, Jaroslav Slivka, Nikola Jovancevic, László Oláh, Gergő Hamar and Dezső Varga

2016 *EPL* **113** 58001

Cosmic-ray muons can be used for imaging of large structures, or high-density objects with high atomic number. The first task can be performed by measurement of muon absorption within very thick material layers, while the second approach is based on muon multiple scattering. However, the muon imaging of small structures with low atomic number and density was not yet solved appropriately. Here we show the first results of cosmic-ray muon imaging of small objects made of elements of low atomic number. This novel approach includes detection of secondary particles produced by muons, which were not used at all in previous muon imaging methods. Thus, the list of elements, as well as the range of dimensions of objects which can be imaged are significantly expanded.

Osman Kahraman

Christoph A. Haselwandter

Stochastic single-molecule dynamics of synaptic membrane protein domains

Osman Kahraman, Yiwei Li and Christoph A. Haselwandter

2016 *EPL* **115** 68006

Motivated by single-molecule experiments on synaptic membrane protein domains, we use a stochastic lattice model to study protein reaction and diffusion processes in crowded membranes. We find that the stochastic reaction-diffusion dynamics of synaptic proteins provide a simple physical mechanism for collective fluctuations in synaptic domains, the molecular turnover observed at synaptic domains, key features of the single-molecule trajectories observed for synaptic proteins, and spatially inhomogeneous protein lifetimes at the cell membrane. Our results suggest that central aspects of the single-molecule and collective dynamics observed for membrane protein domains can be understood in terms of stochastic reaction-diffusion processes at the cell membrane.

J. J. Crofts

R. O'Dea

Structure-function clustering in multiplex brain networks

J. J. Crofts, M. Forrester and R. O'Dea

2016 *EPL* **116** 18003

A key question in neuroscience is to understand how a rich functional repertoire of brain activity arises within relatively static networks of structurally-connected neural populations: elucidating the subtle interactions between evoked 'functional connectivity' and the underlying 'structural connectivity' has the potential to address this. These structural-functional networks (and neural networks more generally) are more naturally described using a multilayer or multiplex network approach, in favour of standard single-layer network analyses that are more typically applied to such systems. In this letter, we address such issues by exploring important structure-function relations in the Macaque cortical network by modelling it as a duplex network that comprises an anatomical layer, describing the known (macro-scale) network topology of the Macaque monkey, and a functional layer derived from simulated neural activity. We investigate and characterize correlations between structural and functional layers, as system parameters controlling simulated neural activity are varied, by employing recently described multiplex network measures. Moreover, we propose a novel measure of multiplex structure-function clustering which allows us to investigate the emergence of functional connections that are distinct from the underlying cortical structure, and to highlight the dependence of multiplex structure on the neural dynamical regime.

APPLIED & INTERDISCIPLINARY TOPICS

M. Chiang

D. Marenduzzo

Glass transitions in the cellular Potts model

M. Chiang and D. Marenduzzo

2016 *EPL* **116** 28009

We study the dynamical transition between a fluid-like and a solid-like phase in a confluent cell monolayer, by using the cellular Potts model and computer simulations. We map out the phase diagram as a function of interfacial tension and of cell motility. While in the fluid phase there is normal diffusion, in the solid phase we observe sub-diffusion, very slow relaxation, and ageing, thereby strongly suggesting that this phase is glassy. Our results complement previous theoretical work within the vertex model and show that the cellular Potts model can account for the experimentally observed glassy dynamics of some biological tissues.

Attila Szolnoki

Matjaž Perc

Collective influence in evolutionary social dilemmas

Attila Szolnoki and Matjaž Perc

2016 *EPL* **113** 58004

When evolutionary games are contested in structured populations, the degree of each player in the network plays an important role. If they exist, hubs often determine the fate of the population in remarkable ways. Recent research based on optimal percolation in random networks has shown, however, that the degree is neither the sole nor the best predictor of influence in complex networks. Low-degree nodes may also be optimal influencers if they are hierarchically linked to hubs. Taking this into account leads to the formalism of collective influence in complex networks, which as we show here, has far-reaching implications for the favorable resolution of social dilemmas. In particular, there exists an optimal hierarchical depth for the determination of collective influence that we use to describe the potency of players for passing their strategies, which depends on the strength of the social dilemma. Interestingly, the degree, which corresponds to the baseline depth zero, is optimal only when the temptation to defect is small. Our research reveals that evolutionary success stories are related to spreading processes which are rooted in favorable hierarchical structures that extend beyond local neighborhoods.

Lisa Rapp, Fabian Bergmann and Walter Zimmermann

Pattern orientation in finite domains without boundaries

Lisa Rapp, Fabian Bergmann and Walter Zimmermann

2016 *EPL* **113** 28006

We investigate the orientation of nonlinear stripe patterns in finite domains. Motivated by recent experiments, we introduce a control parameter drop from supercritical inside a domain to subcritical outside without boundary conditions at the domain border. As a result, stripes align perpendicularly to shallow control parameter drops. For steeper drops, non-adiabatic effects lead to a surprising orientational transition to parallel stripes with respect to the borders. We demonstrate this effect in terms of the Brusselator model and generic amplitude equations.

Andrew Mellor

R. K. P. Zia

Characterization of the nonequilibrium steady state of a heterogeneous nonlinear q-voter model with zealotry

Andrew Mellor, Mauro Mobilia and R. K. P. Zia

2016 *EPL* **113** 48001

We introduce a heterogeneous nonlinear q-voter model with zealots and two types of susceptible voters, and study its *non-equilibrium* properties when the population is finite and well mixed. In this two-opinion model, each individual supports one of two parties and is either a zealot or a susceptible voter of type q_1 or q_2. While here zealots never change their opinion, a q_i-susceptible voter ($i = 1.2$) consults a group of q_i neighbors at each time step, and adopts their opinion if all group members agree. We show that this model violates the detailed balance whenever $q_1 \neq q_2$ and has surprisingly rich properties. Here, we focus on the characterization of the model's non-equilibrium stationary state (NESS) in terms of its probability distribution and currents in the distinct regimes of low and high density of zealotry. We unveil the NESS properties in each of these phases by computing the opinion distribution and the circulation of probability currents, as well as the two-point correlation functions at unequal times (formally related to a "probability angular momentum"). Our analytical calculations obtained in the realm of a linear Gaussian approximation are compared with numerical results.

Geophysics, astronomy & astrophysics

Guillem Domènech

Misao Sasaki

Inflationary magnetogenesis with broken local U(1) symmetry

Guillem Domènech, Chunshan Lin and Misao Sasaki

2016 *EPL* **115** 19001

We point out that a successful inflationary magnetogenesis could be realised if we break the local $U(1)$ gauge symmetry during inflation. The effective electric charge is fixed as a fundamental constant, which allows us to obtain an almost scale-invariant magnetic spectrum avoiding both the strong coupling and back reaction problems. We examine the corrections to the primordial curvature perturbation due to these stochastic electromagnetic fields and find that, at both linear and non-linear orders, the contributions from the electromagnetic field are negligible compared to those created from vacuum fluctuations. Finally, the $U(1)$ gauge symmetry is restored at the end of inflation.

Y. Friedman

Predicting Mercury's precession using simple relativistic Newtonian dynamics

Y. Friedman and J. M. Steiner

2016 *EPL* **113** 39001

We present a new simple relativistic model for planetary motion describing accurately the anomalous precession of the perihelion of Mercury and its origin. The model is based on transforming Newton's classical equation for planetary motion from absolute to real spacetime influenced by the gravitational potential and introducing the concept of influenced direction.

EPL subject compilations

To ensure that researchers find the articles they need quickly and simply, a series of subject compilations are listed on the website to showcase high-quality articles in specific areas. Some compilations have their own co-editor, a leading scientist in that field who is responsible for overseeing the review process, selecting referees and making publication decisions for manuscripts submitted so that the very best quality research is published. For several compilations an expert has written a brief introduction to the topic. The following compilations can be found on the website at **epljournal.org/compilations**. Content is often made free to read during relevant conferences and events.

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In 2016 EPL identified a select number of events to receive sponsorship funding. Several conferences were awarded sums to assist with registration, travel and/or accommodation fees to allow young researchers to attend. Additionally, at most of the events awards were given for best poster and/or oral presentations. Recipients received a cash award, a certificate and an invitation to submit their poster or next article to EPL. Sponsorship or support was available at the following conferences, schools or workshops.

- Flowing Matter, Porto
- PHOTOPTICS 2016, Rome
- DPG Biophysics symposium, Regensburg
- Middle European Cooperation in Statistical Physics (MECO 41), Vienna
- Phase Transitions & Critical Phenomena (PTCP), Coventry
- EMN Terahertz, San Sebastian
- EPS Young Minds Prize, Budapest
- IOP Plasma Physics, Skye
- Disordered Systems, Brescia
- Graphene Week 2016, Warsaw
- Vibrations at Surfaces, San Sebastian
- Metrology – from physics fundamentals to quality of life (Course 196), Varenna
- Foundations of Quantum Theory (Course 197), Varenna
- Quantum Simulators (Course 198), Varenna
- META'16/AES, Malaga
- Swiss Physical Society meeting, Lugano
- TeraHz physics (summer school), Erice
- Epioptics: Silicene 2 (summer school), Erice
- StatPhys26, Lyon
- Austrian Physical Society meeting, Vienna
- EPS Condensed Matter Division meeting (CMD26), Groningen
- Atomically Controlled Surfaces, Interfaces & Nanostructures (ACSIN), Rome
- Correlations, Integrability, and Criticality in Quantum Systems (CICQS), Evora

Events calendar 2017

The EPL team regularly attends conferences around the world to meet the research community and promote the journal. If you would like EPL to attend or support your event, please contact the Executive Editor at **info@epljournal.org**. The following provisional list of conferences may be supported by EPL or exhibit EPL material. As this listing changes frequently as new events arise, please keep up to date by viewing **epljournal.org/events**.

- **Nanometa** Seefeld, Austria, 4–7 January
- **Flowing Matter 2017** Porto, Portugal, 23–27 January
- **Middle European Cooperation in Statistical Physics (MECO42)** Lyon, France, 8–10 February
- **PHOTOPTICS 2017** Porto, Portugal, 27 February – 1 March
- **DPG Spring Meeting** Dresden, Germany, 19–24 March
- **Conference of Young Scientists in Atomic and Molecular Physics (J²IFAM IX)** Seville, Spain, 22–24 March
- **Graphene 2017** Barcelona, Spain, 28–31 March
- **Annual European Rheology Conference (AERC)** Copenhagen, Denmark, 3–6 April
- **E-MRS Spring** Strasbourg, France, 22–26 May
- **Nuclear Physics in Astrophysics VIII** Catania, Sicily, 18–23 June
- **Physics of Magnetism** Poznan, Poland, 26–30 June
- **CLEO/Europe-EQEC 2017** Munich, Germany, 25–29 June
- **Physics of and Sciences with X-ray Free Electron Lasers (Course 199)** Varenna, Italy, 26 June – 1 July
- **Gravitational Waves and Cosmology (Course 200)** Varenna, Italy, 3–12 July
- **Nuclear Physics with Stable and Radioactive Ion Beams (Course 201)** Varenna, Italy, 14–19 July
- **Liquids 2017** Ljubljana, Slovenia, 17–21 July
- **META'17** Seoul, South Korea, 25–28 July
- **Joint Swiss/Austrian Physical Society Meeting** Geneva, Switzerland, 21–25 August
- **Metamaterials 2017** Marseille, France, 27 August – 2 September
- **Iberian Rheology meeting (IBEREO)** Valencia, Spain, 6–8 September
- **Graphene Week 2017** Athens, Greece, 25–29 September

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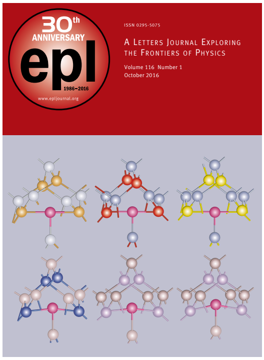
A circularly symmetric polariton condensate driven in the OPO regime, before the spontaneous appearance of a rotating vortex ring, adapted from **J.O. Hamp, A.K. Balin, F.M. Marchetti, D. Sanvitto and M.H. Szymańska** 2015 *EPL* **110** 57006.

Probability related to retrieving the information from a quantum walk memory at different times, adapted from **C. M. Chandrashekar and Th. Busch** 2015 *EPL* **110** 10005.

Normal-superconductor phase boundary – large orbits of superconducting electrons near the phase boundary extend into the normal region, adapted from **J. E. Hirsch** 2016 *EPL* **114** 57001.



Anion interstitial defect structure in zinc-blende material, adapted from **Yuan Yin, Guangde Chen, Honggang Ye, Xiangyang Duan, Youzhang Zhu and Yelong Wu** 2016 *EPL* **114** 36001.

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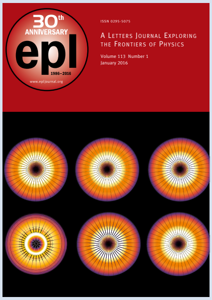

We would like to thank all of our authors, referees, board members, partners and supporters across the world for their vital contribution to the work and progress of EPL.

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