

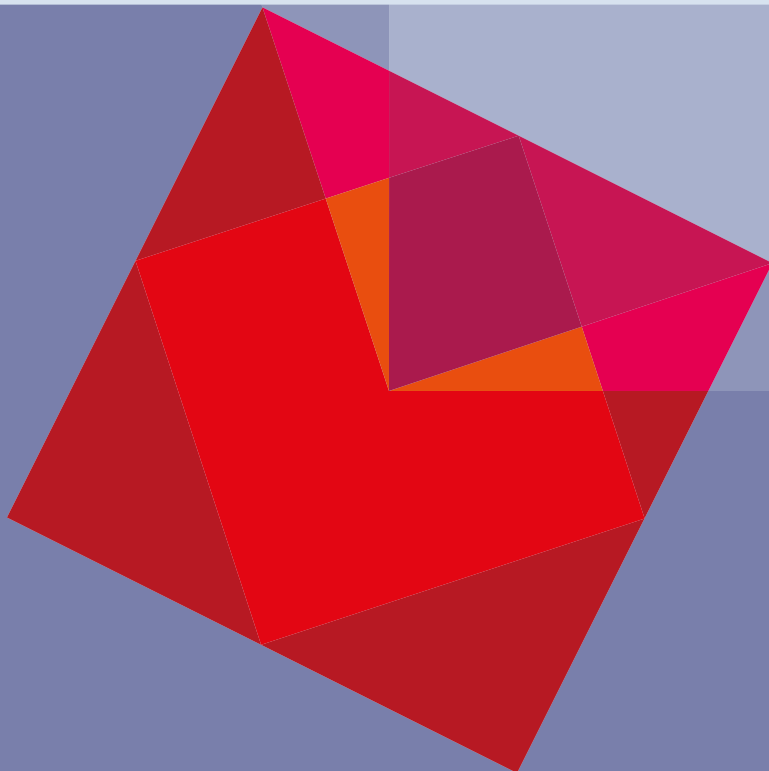
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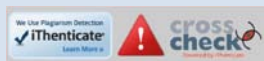
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Welcome

Professor Michael Schreiber
Editor-in-Chief, EPL

Once more we have compiled a Best of the Year collection of published articles. These have been selected on the basis of the number of downloads, citations and – mostly – the Editor's choices. Our co-editors nominated 60 of the more than 800 articles published in 2012 as Editor's choice, which identifies the best of the best, because our rejection rate of more than 60% means choosing the best manuscripts in the first instance.

The broad spectrum of EPL articles is reflected in this brochure, ranging from molecular machines to quantum entanglement and superluminal neutrinos, from avalanches to earthquakes and public co-operation, but also covering mythological networks, the game of go, and DNA origami. Due to the restricted space, many other excellent papers could not be included, but you can find them in the extended online version of our Highlights collection at epjjournal.org/highlights-2012.

If you are particularly interested in a certain subject, I also point you towards epjjournal.org/compilations where you can read our topical compilations in full.

EPL is a journal run by active scientists for scientists, and we like to contribute to the community as much as possible. One way in which we do this is by sponsoring poster prizes for young scientists. The conferences we sponsored in 2012 are listed on p30; if you are organizing a meeting and are interested in such a prize, feel free to contact us at info@epjjournal.org.



From the Executive Editor

Dr Graeme Watt
Executive Editor, EPL

The end of 2012 completed a century of EPL volumes. Isn't it now time for you to submit one of your best articles to EPL? During this year there will be significant development and improvement in submission, tracking, searching and manipulation tools on the websites. High-quality content is being identified by the co-editors for further promotion via press releases, targeted mailshots and compilation page listings. An increasing number of events are receiving sponsorship for young researchers, for poster prizes and/or for support. The rapid publication time, six pages of A4 space available, together with increased marketing and promotional activities, aim to ensure that your research reaches a worldwide readership in a timely manner. I hope that you enjoy this selection of highlighted articles. Thank you for your support and please continue to strengthen EPL with more submissions.

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Front cover image: The magnetic Brillouin zone and the original lattice Brillouin zone of the checkerboard antiferromagnetic $K_{0.5}Fe_{1.5}Se_2$, adapted from **Huan Li and Ya Liu** 2012 *EPL* **98** 47006; artistic impression by Frédérique Swist.

Quantum mechanics, mathematical methods & statistical physics

Entropic uncertainty and the quantum phase transition in the Dicke model

E. Romera, M. Calixto and Á. Nagy

2012 *EPL* **97** 20011

We show that the description of the quantum phase transition in terms of the entropic uncertainty relation turns out to be more suitable than in terms of the standard variance-based uncertainty relation. The entropic uncertainty relation detects the quantum phase transition in the Dicke model and it provides a correct description of the quantum fluctuations or quantum uncertainty of the system.

Efficiency of molecular machines with continuous phase space

N. Golubeva, A. Imparato and L. Peliti

2012 *EPL* **97** 60005

We consider a molecular machine described as a Brownian particle diffusing in a tilted periodic potential. We evaluate the absorbed and released power of the machine as a function of the applied molecular and chemical forces, by using the fact that the times for completing a cycle in the forward and the backward direction have the same distribution, and that the ratio of the corresponding splitting probabilities can be simply expressed as a function of the applied force. We explicitly evaluate the efficiency at maximum power for a simple sawtooth potential. We also obtain the efficiency at maximum power for a broad class of 2-D models of a Brownian machine and find that loosely coupled machines operate with a smaller efficiency at maximum power than their strongly coupled counterparts.

QUANTUM MECHANICS, MATHEMATICAL METHODS & STATISTICAL PHYSICS



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Measuring non-Markovianity of processes with controllable system-environment interaction

Jian-Shun Tang, Chuan-Feng Li, Yu-Long Li, Xu-Bo Zou, Guang-Can Guo, Heinz-Peter Breuer, Elsi-Mari Laine and Jyrki Piilo

2012 *EPL* **97** 10002

Non-Markovian processes have recently become a central topic in the study of open quantum systems. We realize experimentally non-Markovian decoherence processes of single photons by combining time delay and evolution in a polarization-maintaining optical fibre. The experiment allows the identification of the process with strongest memory effects as well as the determination of a recently proposed measure for the degree of quantum non-Markovianity based on the exchange of information between the open system and its environment. Our results show that an experimental quantification of memory in quantum processes is indeed feasible which could be useful in the development of quantum memory and communication devices.

Efficiency at maximum power of minimally nonlinear irreversible heat engines

Y. Izumida and K. Okuda

2012 *EPL* **97** 10004

We propose the minimally nonlinear irreversible heat engine as a new general theoretical model to study the efficiency at the maximum power η^* of heat engines operating between the hot heat reservoir at the temperature T_h and the cold one at T_c ($T_c \leq T_h$). Our model is based on the extended Onsager relations with a new nonlinear term meaning the power dissipation. In this model, we show that η^* is bounded from the upper side by a function of the Carnot efficiency $\eta_c \equiv 1 - T_c/T_h$ as $\eta^* \leq \eta_c / (2 - \eta_c)$. We demonstrate the validity of our theory by showing that the low-dissipation Carnot engine can easily be described by our theory.

QUANTUM MECHANICS, MATHEMATICAL METHODS & STATISTICAL PHYSICS



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Casimir forces beyond the proximity approximation

G. Bimonte, T. Emig, R. L. Jaffe and M. Kardar

2012 *EPL* **97** 50001

The proximity force approximation (PFA) relates the interaction between closely spaced, smoothly curved objects to the force between parallel plates. Precision experiments on Casimir forces necessitate, and spur research on, corrections to the PFA. We use a derivative expansion for gently curved surfaces to derive the leading curvature modifications to the PFA. Our methods apply to any homogeneous and isotropic materials; here we present results for Dirichlet and Neumann boundary conditions and for perfect conductors. A Padé extrapolation constrained by a multipole expansion at large distance and our improved expansion at short distances provide an accurate expression for the sphere/plate Casimir force at all separations.

Entanglement entropies in free-fermion gases for arbitrary dimension

P. Calabrese, M. Mintchev and E. Vicari

2012 *EPL* **97** 20009

We study the entanglement entropy of connected bipartitions in free-fermion gases of N particles in arbitrary dimension d . We show that the von Neumann and Rényi entanglement entropies grow asymptotically as $N^{(d-1)/d} \ln N$, with a prefactor that is analytically computed using the Widom conjecture both for periodic and open boundary conditions. The logarithmic correction to the power-law behaviour is related to the area-law violation in lattice free fermions. These asymptotic large- N behaviours are checked against exact numerical calculations for N -particle systems.

Elementary particles, fields & nuclear physics

Measurement of the forward charged-particle pseudorapidity density in pp collisions at $\sqrt{s} = 7$ TeV with the TOTEM experiment

The TOTEM Collaboration

2012 *EPL* **98** 31002

The TOTEM experiment has measured the charged-particle pseudorapidity density $dN_{\text{ch}}/d\eta$ in pp collisions at $\sqrt{s} = 7$ TeV for $5.3 < |\eta| < 6.4$ in events with at least one charged particle with transverse momentum above 40 MeV/c in this pseudorapidity range. This extends the analogous measurement performed by the other LHC experiments to the previously unexplored forward η region. The measurement refers to more than 99% of non-diffractive processes and to single and double diffractive processes with diffractive masses above ~ 3.4 GeV/ c^2 , corresponding to about 95% of the total inelastic cross-section. The $dN_{\text{ch}}/d\eta$ has been found to decrease with $|\eta|$, from $3.84 \pm 0.01(\text{stat}) \pm 0.37(\text{syst})$ at $|\eta| = 5.375$ to $2.38 \pm 0.01(\text{stat}) \pm 0.21(\text{syst})$ at $|\eta| = 6.375$. Several MC generators have been compared to data; none of them has been found to fully describe the measurement.

Bismuth-loaded plastic scintillators for gamma-ray spectroscopy

B. L. Rupert, N. J. Cherepy, B. W. Sturm, R. D. Sanner and S. A. Payne

2012 *EPL* **97** 22002

Polyvinylcarbazole polymer scintillators with high loading of a bismuth organometallic exhibit good light yields, and are found to be capable of gamma-ray spectroscopy. When activated by a standard fluor, diphenylanthracene, a bismuth-loaded polymer produces $\sim 12,000$ photons/MeV, exhibits an emission maximum at 420 nm, a ~ 15 ns decay, and energy resolution of 9% at 662 keV is measured. The same bismuth-loaded polymer doped with an iridium complex fluor has an emission maximum of 500 nm, a decay time of 1.2 μs , a light yield of $\sim 30,000$ photons/MeV, and energy resolution better than 7% FWHM at 662 keV.

ELEMENTARY PARTICLES, FIELDS & NUCLEAR PHYSICS

The hypothesis of superluminal neutrinos: Comparing OPERA with other data

A. Drago, I. Masina, G. Pagliara and R. Tripiccone

2012 EPL **97** 21002

The OPERA Collaboration reported evidence for muonic neutrinos travelling slightly faster than light in vacuum. While awaiting further checks from the experimental community, here we aim at exploring some theoretical consequences of the hypothesis that muonic neutrinos are superluminal, considering in particular the tachyonic and the Coleman-Glashow cases. We show that a tachyonic interpretation is not only hardly reconciled with OPERA data on energy dependence, but that it clashes with neutrino production from pion and with neutrino oscillations. A Coleman-Glashow superluminal neutrino beam would also have problems with pion decay kinematics for the OPERA setup; it could be easily reconciled with SN1987a data, but then it would be very problematic to account for neutrino oscillations.

Is radioactive decay really exponential?

P. J. Aston

2012 EPL **97** 52001

Radioactive decay of an unstable isotope is widely believed to be exponential. This view is supported by experiments on rapidly decaying isotopes but is more difficult to verify for slowly decaying isotopes. The decay of ^{14}C can be calibrated over a period of 12,550 years by comparing radiocarbon dates with dates obtained from dendrochronology. It is well known that this approach shows that radiocarbon dates of over 3,000 years are in error, which is generally attributed to past variation in atmospheric levels of ^{14}C . We note that predicted atmospheric variation (assuming exponential decay) does not agree with results from modelling, and that theoretical quantum mechanics does not predict exact exponential decay. We give mathematical arguments that non-exponential decay should be expected for slowly decaying isotopes and explore the consequences of non-exponential decay. We propose an experimental test of this prediction of non-exponential decay for ^{14}C . If confirmed, a foundation stone of current dating methods will have been removed; requiring a radical reappraisal both of radioisotope dating methods and of currently predicted dates obtained using these methods.

Atomic & molecular physics



N. Goldman
Université Libre de
Bruxelles, Belgium

Topological phase transitions between chiral and helical spin textures in a lattice with spin-orbit coupling and a magnetic field

N. Goldman, W. Beugeling and C. Morais Smith

2012 *EPL* **97** 23003



C. Morais Smith
Utrecht University,
The Netherlands

We consider the combined effects of large spin-orbit couplings and a perpendicular magnetic field in a 2D honeycomb fermionic lattice. This system provides an elegant setup to generate versatile spin textures propagating along the edge of a sample. The spin-orbit coupling is shown to induce topological phase transitions between a helical quantum spin Hall phase and a chiral spin-imbalanced quantum Hall state. Besides, we find that the spin orientation of a single topological edge state can be tuned by a Rashba spin-orbit coupling, opening an interesting route towards quantum spin manipulation. We discuss the possible realization of our results using cold atoms trapped in optical lattices, where large synthetic magnetic fields and spin-orbit couplings can be engineered and finely tuned. In particular, this system would lead to the observation of a time-reversal symmetry-broken quantum spin Hall phase.

Spin-charge-density wave in a rounded-square Fermi surface for ultracold atoms

D. Makogon, I. B. Spielman and C. Morais Smith

2012 *EPL* **97** 33002

We derive and discuss an experimentally realistic model describing ultracold atoms in an optical lattice including a commensurate, but staggered, spin-flip term. The resulting band structure is quite exotic; fermions in the third band have an unusual rounded picture-frame Fermi surface (essentially two concentric squircles), leading to imperfect nesting. We develop a generalized theory describing the spin and charge degrees of freedom simultaneously at the random-field-approximation level, and show that the system can develop a coupled spin-charge-density wave order. Our generic approach can be used to study spin and charge instabilities in many materials, such as high- T_c superconductors, organic compounds, graphene, and iron pnictides.

Electromagnetism, optics, acoustics, heat transfer, classical mechanics & fluid dynamics



Dr Lionel Rossi
Imperial College,
London, UK

Lamination and mixing in laminar flows driven by Lorentz body forces

L. Rossi, D. Doorly and D. Kustrin

2012 EPL **97** 14006

We present a new approach to the design of mixers. This approach relies on a sequence of tailored flows coupled with a new procedure to quantify the local degree of striation, called lamination. Lamination translates to the distance over which the molecular diffusion needs to act to finalise mixing. A novel *in situ* mixing is achieved by the tailored sequence of flows. This sequence is shown with the property that material lines and lamination grow exponentially, according to processes akin to the well-known baker's map. The degree of mixing (stirring coefficient) likewise shows exponential growth before the saturation of the stirring rate. Such saturation happens when the typical striations' thickness is smaller than the diffusion's length scale. Moreover, without molecular diffusion, the predicted striations' thickness would be smaller than the size of an atom of hydrogen within 40 flow turnover times. In fact, we conclude that about 3 minutes, i.e. 15 turnover times, are sufficient to mix species with very low diffusivities, e.g. suspensions of virus, bacteria, human cells, and DNA.



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Dr Ivar Martin, Los Alamos National Laboratory, USA

ELECTROMAGNETISM, OPTICS, ACOUSTICS, HEAT TRANSFER, CLASSICAL MECHANICS & FLUID DYNAMICS



Günter Nimtz
University of Cologne,
Germany

Giant negative group time delay by microwave adaptors

A. Carôt, H. Aichmann and G. Nimtz

2012 EPL **98** 64002

A Fabry-Perot-like interferometer with two microwaveguide adaptors as reflectors creates a passive dielectric medium with a negative group delay time due to polarization shift. In that case rectangular with circular waveguides are adapted. A rotational strain of the polarization vector by one of the adaptors is coupled with the excitation of a drastic negative group velocity. The adapted rectangular and circular waveguides have the same dispersion. The input rectangular waveguide mode is linearly polarized, whereas the basic mode of the adapted circular waveguide is circularly polarized. A 20 m long circular waveguide connects the input with the output adaptor. Experiments are reproduced in the frequency and in the time domain. A polarization turn of the two different handed reflected circular wave modes causes the observed negative group velocity.



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Lattice Boltzmann study of thermal phase separation: Effects of heat conduction, viscosity and Prandtl number

Yanbiao Gan, Aiguo Xu, Guangcai Zhang, Ping Zhang and Yingjun Li

2012 EPL **97** 44002

We investigate the effects of heat conduction, viscosity, and Prandtl number on thermal liquid-vapour separation via a lattice Boltzmann model for van der Waals fluids. The set of Minkowski measures on the density field enables us to divide exactly the stages of the spinodal decomposition (SD) and domain growth. The duration t_{sd} of the SD stage decreases with increasing the heat conductivity κ , but increases with increasing the viscosity η . The two relations can be fitted by $t_{sd} = a + b/\kappa$ and $t_{sd} = c + d\eta + (e\eta)^3$, respectively, where a , b , c , d and e are fitting parameters. For fixed Prandtl number Pr , when η is less than a critical value η_c , t_{sd} shows an inverse power-law relationship with η . However, when $\eta > \eta_c$, t_{sd} for $Pr > 1$ shows qualitatively different behaviour. From the evolution of the Péclet number Pe , the separation procedure can also be divided into two stages. During the first stage, the convection effects become more dominant with time over those of the diffusivity, while they are reverse in the second stage.

Physics of gases, plasmas & electrical discharges

Plasmon resonant light scattering on spheroidal metallic nanoparticle embedded in a dielectric matrix

N. I. Grigorchuk

2012 *EPL* **97** 45001

The efficiency of light scattering on metal nanoparticles with an excitation of plasmon resonance electron vibrations is calculated. The behaviour of the light scattering in a region of the surface plasmon resonance is studied in detail. A simple universal formula for light scattering cross-section by a metal nanoparticle with different shape embedded in any dielectric media is obtained. It is shown that the distance between the doublet peaks makes it possible to estimate the degree of oblateness or prolateness of a nanoparticle. The sensitivity to the shape and size of a metal nanoparticle, as well as to the scattering angle is illustrated for the Au nanoparticle.



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The formation of electrostatic shocks in quantum plasmas with relativistically degenerate electrons

B. Eliasson and P. K. Shukla

2012 *EPL* **97** 15001

The formation of electrostatic shocks in a super-dense plasma composed of relativistically degenerate electrons and fully ionized ions is theoretically investigated. We find analytic solutions in the form of simple waves and derive expressions for shock speeds in limiting cases. The theory has applications to large-amplitude acoustic waves excited in white dwarf stars due to dramatic events such as collision with other astrophysical bodies or supernova explosions.

PHYSICS OF GASES, PLASMAS & ELECTRICAL DISCHARGES



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Covariant form of the ideal magnetohydrodynamic "connection theorem" in a relativistic plasma

F. Pegoraro

2012 *EPL* **99** 35001

The magnetic connection theorem of ideal magnetohydrodynamics by Newcomb (Newcomb W. A., *Ann. Phys. (N.Y.)*, **3** (1958) 347) and its covariant formulation are rederived and reinterpreted in terms of a "time resetting" projection that accounts for the loss of simultaneity in different reference frames between spatially separated events.



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Lingti Kong
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Composites,
Shanghai Jiao Tong
University, China

Dynamical stability of iron under high-temperature and high-pressure conditions

L. T. Kong, J. F. Li, Q. W. Shi, H. J. Huang and K. Zhao

2012 EPL **97** 56004

The dynamical stability of iron under high-temperature and high-pressure conditions was investigated based on the phonons evaluated by using a recently developed method. It is revealed that both the fcc-Fe and the hcp-Fe are dynamically stable in a wide temperature and pressure range. The bcc-Fe phase can be stable as well, while in a limited temperature/pressure regime bounded by a dynamical stability limit and a harmonic limit. Direct evidence shows that it is the entropy term that plays a critical role in stabilizing the bcc-Fe under high-temperature and high-pressure conditions.

Distribution of velocities in an avalanche

P. Le Doussal and K. J. Wiese

2012 EPL **97** 46004

For a driven elastic object near depinning, we derive from first principles the distribution of instantaneous velocities in an avalanche. We prove that above the upper critical dimension, $d \geq d_{uc}$, the n -times distribution of the centre-of-mass velocity is equivalent to the prediction from the ABBM stochastic equation. Our method allows one to compute space and time dependence from an instanton equation. We extend the calculation beyond mean field, to lowest order in $E = d_{uc} - d$.

CONDENSED MATTER: STRUCTURAL, MECHANICAL & THERMAL PROPERTIES



Seung-Woo Son
Complexity Science
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Calgary, Canada

Percolation theory on interdependent networks based on epidemic spreading

Seung-Woo Son, Golnoosh Bizhani, Claire Christensen, Peter Grassberger and Maya Paczuski

2012 *EPL* **97** 16006

We consider percolation on interdependent locally treelike networks, recently introduced by Buldyrev S. V. *et al.*, *Nature*, **464** (2010) 1025, and demonstrate that the problem can be simplified conceptually by deleting all references to cascades of failures. Such cascades do exist, but their explicit treatment just complicates the theory – which is a straightforward extension of the usual epidemic spreading theory on a single network. Our method has the added benefits that it is directly formulated in terms of an order parameter and its modular structure can be easily extended to other problems, e.g. to any number of interdependent networks, or to networks with dependency links.



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



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Switzerland

Magnon-driven quantum-dot heat engine

Björn Sothmann and Markus Büttiker

2012 *EPL* **99** 27001

We investigate a heat to charge current converter consisting of a single-level quantum dot coupled to two ferromagnetic metals and one ferromagnetic insulator held at different temperatures. We demonstrate that this nanoengine can act as an optimal heat to spin-polarized charge current converter in an antiparallel geometry, while it acts as a heat to pure spin current converter in the parallel case. We discuss the maximal output power of the device and its efficiency.



Jian-Xin Zhu
Los Alamos National
Laboratory, USA

Electronic structure and correlation effects in PuCoIn_5 as compared to PuCoGa_5

Jian-Xin Zhu, P. H. Tobash, E. D. Bauer, F. Ronning, B. L. Scott, K. Haule, G. Kotliar, R. C. Albers and J. M. Wills

2012 *EPL* **97** 57001

Since their discovery nearly a decade ago, plutonium-based superconductors have attracted considerable interest, which is now heightened by the latest discovery of superconductivity in PuCoIn_5 . In the framework of density functional theory (DFT) within the generalized gradient approximation (GGA) together with dynamical mean-field theory (DMFT), we present a comparative study of the electronic structure of superconducting PuCoIn_5 with an expanded unit cell volume relative to its PuCoGa_5 cousin. Overall, a similar GGA-based electronic structure, including the density of states, energy dispersion, and Fermi surface topology, was found for both compounds. The GGA Pu 5f band was narrower in PuCoIn_5 than in PuCoGa_5 due to the expanded lattice, resulting in an effective reduction of Kondo screening in the former system, as also shown by our DMFT calculations.

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

Revealing common artifacts due to ferromagnetic inclusions in highly oriented pyrolytic graphite

M. Sepioni, R. R. Nair, I.-Ling Tsai, A. K. Geim and I. V. Grigorieva

2012 EPL 97 47001

We report on an extensive investigation to figure out the origin of room temperature ferromagnetism that is commonly observed by SQUID magnetometry in highly oriented pyrolytic graphite (HOPG). Electron backscattering and X-ray microanalysis revealed the presence of micron-size magnetic clusters (predominantly Fe) that are rare and would be difficult to detect without careful search in a scanning electron microscope in the backscattering mode. The clusters pin to crystal boundaries and their quantities match the amplitude of typical ferromagnetic signals. No ferromagnetic response is detected in samples where we could not find such magnetic inclusions. Our experiments show that the frequently reported ferromagnetism in pristine HOPG is most likely to originate from contamination with Fe-rich inclusions introduced presumably during crystal growth.

Thermomagnonic spin transfer and Peltier effects in insulating magnets

Alexey A. Kovalev and Yaroslav Tserkovnyak

2012 EPL 97 67002

We study the coupled magnon energy transport and collective magnetization dynamics in ferromagnets with magnetic textures. By constructing a phenomenological theory based on irreversible thermodynamics, we describe the motion of domain walls by thermal gradients and the generation of heat flows by magnetization dynamics. From a microscopic description based on magnon kinetics, we estimate the transport coefficients and analyse the feasibility of energy-related applications in insulating ferromagnets, such as yttrium iron garnet and europium oxide.

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

Non-conventional Anderson localization in bilayered structures

E. J. Torres-Herrera, F. M. Izrailev and N. M. Makarov

2012 EPL **98** 27003

We resolve the problem of non-conventional Anderson localization emerging in bilayered periodic-on-average structures with alternating layers of materials with positive and negative refraction indices. Recently, it was numerically discovered that in such structures with weak fluctuations of refractive indices, the localization length L_{loc} can be enormously large for small wave frequencies ω . Within a new approach allowing us to go beyond the second order of perturbation theory, we derive the expression for L_{loc} valid for any ω and small variance of disorder, $\sigma^2 \ll 1$. In the limit $\omega \rightarrow 0$ one gets a quite specific dependence, $L_{\text{loc}}^{-1} \propto \sigma^4 \omega^8$. Our approach allows one to establish the conditions under which this effect occurs.

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Interdisciplinary topics

Modelling the folding of DNA origami

J. M. Arbona, J. Elezgaray and J. P. Aimé

2012 *EPL* **100** 28006

DNA-based nanostructures built from a long single-stranded DNA scaffold, known as DNA origamis, are at the basis of many applications. Despite their widespread development, many basic questions concerning the mechanisms of formation of DNA origamis have not yet been addressed. For instance, the robustness of different designs against factors such as the internal topology, or the influence of the staple pattern, are handled empirically. We have developed a model for the folding and melting processes of DNA origamis that is able to reproduce accurately several thermodynamic quantities measurable from UV absorption experiments. This model incorporates not only the origami sequence but also its topology. We show that cooperativity is key to quantitatively understand the folding process. The model can also be used to design a new distribution of crossovers that increases the robustness of the DNA template, a necessary step for technological development.

Optimal working conditions for thermoelectric generators with realistic thermal coupling

Y. Apertet, H. Ouerdane, O. Glavatskaya, C. Goupil and P. Lecoeur

2012 *EPL* **97** 28001

We study how maximum output power can be obtained from a thermoelectric generator (TEG) with non-ideal heat exchangers. We demonstrate with an analytic approach based on a force-flux formalism that the sole improvement of the intrinsic characteristics of thermoelectric modules including the enhancement of the figure of merit is of limited interest: the constraints imposed by the working conditions of the TEG must be considered on the same footing. Introducing an effective thermal conductance we derive the conditions which permit maximization of both efficiency and power production of the TEG dissipatively coupled to heat reservoirs. Thermal impedance matching must be accounted for as well as electrical impedance matching in order to maximize the output power. Our calculations also show that the thermal impedance does not only depend on the thermal conductivity at zero electrical current: it also depends on the TEG figure of merit. Our analysis thus yields both electrical and thermal conditions permitting optimal use of a thermoelectric generator.

INTERDISCIPLINARY TOPICS



Attila Szolnoki
Research Institute for
Technical Physics and
Materials Science,
Hungary

Evolution of public cooperation on interdependent networks: The impact of biased utility functions

Zhen Wang, Attila Szolnoki and Matjaž Perc

2012 EPL **97** 48001

We study the evolution of public cooperation on two interdependent networks that are connected by means of a utility function, which determines to what extent payoffs in one network influence the success of players in the other network. We find that the stronger the bias in the utility function, the higher the level of public cooperation. Yet the benefits of enhanced public cooperation on the two networks are just as biased as the utility functions themselves. While cooperation may thrive on one network, the other may still be plagued by defectors. Nevertheless, the aggregate level of cooperation on both networks is higher than the one attainable on an isolated network. This positive effect of biased utility functions is due to the suppressed feedback of individual success, which leads to a spontaneous separation of characteristic time scales of the evolutionary process on the two interdependent networks. As a result, cooperation is promoted because the aggressive invasion of defectors is more sensitive to the slowing-down than the build-up of collective efforts in sizable groups.



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Geophysics, astronomy & astrophysics

Has the Mediterranean Sea felt the March 11th, 2011, Mw 9.0 Tohoku-Oki earthquake?

A. Vecchio, M. Anzidei, V. Capparelli, V. Carbone and I. Guerra

2012 *EPL* **98** 59001

The possibility that the tsunami, generated as a consequence of the large Mw 9.0 Tohoku-Oki earthquake of March 11th 2011, could be recorded by the tide gauge stations located in the Mediterranean Sea has been investigated. We find two kinds of transient signatures which should be attributed to the far-field destabilizing effect of the tsunami on the usual tidal components: 1) the excitation of a broad spectrum of frequency fluctuations, superimposed to the diurnal and semidiurnal tidal components, 2) the change of amplitude of the low-frequency tidal components in the Mediterranean, related to the sea surface fluctuation perhaps caused by the direct transmission of the tsunami across Gibraltar.

Quantum vacuum influence on pulsars' spindown evolution

Arnaud Dupays, Carlo Rizzo and Giovanni Fabrizio Bignami

2012 *EPL* **98** 49001

In this letter, we show that Quantum Vacuum Friction (QVF) resulting from the interaction between the magnetic dipole moment of a pulsar and its induced quantum vacuum magnetic dipole moment should play an important role in how a neutron star's spin period evolves. Taking into account this effect we show that magnetars could be understood as a natural evolution of standard pulsars. In particular, for the Crab pulsar, of which the true age is known, we present the first completely coherent time evolution for its period and braking index. For this pulsar and for the B1509-58 pulsar we also give the predicted values of the current first derivative of the braking index that we compare with existing experimental data. Our prediction provides a very important test to confirm or invalidate QVF.

GEOPHYSICS, ASTRONOMY & ASTROPHYSICS

Earth rotation prevents exact solid-body rotation of fluids in the laboratory

J. Boisson, D. Cébron, F. Moisy and P.-P. Cortet

2012 *EPL* **98** 59002

We report direct evidence of a secondary flow excited by the Earth rotation in a water-filled spherical container spinning at constant rotation rate. This so-called tilt-over flow essentially consists in a rotation around an axis which is slightly tilted with respect to the rotation axis of the sphere. In the astrophysical context, it corresponds to the flow in the liquid cores of planets forced by precession of the planet rotation axis, and it has been proposed to contribute to the generation of planetary magnetic fields. We detect this weak secondary flow using a particle image velocimetry system mounted in the rotating frame. This secondary flow consists in a weak rotation, a thousand times smaller than the sphere rotation, around a horizontal axis which is stationary in the laboratory frame. Its amplitude and orientation are in quantitative agreement with the theory of the tilt-over flow excited by precession. These results show that setting a fluid in a perfect solid-body rotation in a laboratory experiment is impossible —unless by tilting the rotation axis of the experiment parallel to the Earth rotation axis.

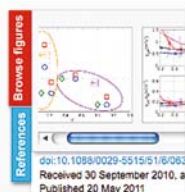
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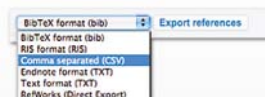
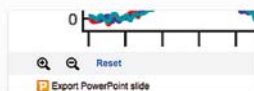


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Full information on the EPL Editorial Board, including the research interests of all of its members, is available on the Editorial Office website at www.epletters.net. Here we introduce six of our co-editors.



Professor Yoicho Ando

Currently a professor at ISIR, Osaka University, Professor Ando has been an active researcher for more than 20 years. In the past he has studied various novel materials that present useful quantum functionalities, such as high-temperature superconductivity or efficient thermoelectricity. His current areas of interest are topological insulators and topological superconductors.



Professor Antonio H. Castro Neto

Antonio Castro Neto, a professor of physics at Boston University, distinguished professor and director of the Graphene Research Centre at the National University of Singapore, has broad interests in condensed matter theory research, such as decoherence in quantum open systems (with applications to quantum computation and NEMS – nanoelectromechanical systems), quantum magnetism in ordered and disordered itinerant magnets, and high-temperature superconductors. His current research interests include graphene, strongly correlated systems, spin and charge density waves, quantum magnetism, superconductivity and disordered magnetic systems.



Professor Udo Seifert

A member of the Editorial Board since 2007, Professor Seifert is currently a full professor of theoretical physics at the University of Stuttgart. His research interests include the theory of condensed matter, including statistical and biological physics and soft matter.



Professor Rosario Fazio

Professor Fazio is Professor of Condensed Matter Physics at Scuola Normale Superiore, a research associate of NEST and group leader of the Quantum Transport and Information (QTI) group. He is primarily interested in quantum transport in nanostructures, solid state quantum information, non-equilibrium dynamics of quantum systems, quantum information and many-body systems, cavity-QED arrays and superconducting NEMS.



Professor Astrid Lambrecht

As CNRS research director, Laboratoire Kastler Brossel, Paris, since 2007, Professor Lambrecht's interests include Casimir forces and the quantum vacuum, physics of nanosystems, decoherence and gravitation, quantum optics and quantum measurements in space-time.



Professor Maciej Lewenstein

Professor Lewenstein of the Catalan Institution for Research and Advanced Studies (ICREA), as well as a group leader at the Institute of Photonic Sciences (ICFO), is recognized for his exceptional contribution to the field of quantum optics and physics of ultracold gases. His theoretical works frequently feature breakthrough experiments, such as the first observation of dark solitons in Bose–Einstein condensates. In the past decade, Professor Lewenstein has focused his research on strongly correlated ultracold quantum gases, which has led to the experimental realization of the so-called quantum simulators: the first dedicated special-purpose quantum computers.

News coverage for EPL articles

As part of our ongoing commitment to promoting authors and their work, we highlight published articles that are considered newsworthy to the media, resulting in a broad range of print, online and broadcast coverage.

One article that made the headlines in 2012 covers universal properties of mythological networks. The press release for this article was published in 33 media outlets, including *The Times*, the *Telegraph*, *Science* and the *Guardian*. In the 90 days following the letter being published in EPL, it had received more than 6000 downloads.

**6000
downloads
in 90 days**

Universal properties of mythological networks

Pádraig Mac Carron and Ralph Kenna

2012 *EPL* **99** 28002

The authors of this article applied statistical mechanical tools to analyse the networks underlying three iconic mythological narratives, with a view to identifying common and distinguishing quantitative features. Of the three narratives, an Anglo-Saxon and a Greek text are mostly believed by historians to be partly historically based, while the third, an Irish epic, is often considered to be fictional. The authors used network analysis in an attempt to discriminate real from imaginary social networks, and place mythological narratives on the spectrum between them. Their research suggests that the perceived artificiality of the Irish narrative can be traced back to irregular features associated with six characters, and renders the plausibility of the Irish text comparable to the others from a network-theoretic point of view.

An article that received a lot of interest in the research community during 2012, and received more than 5000 downloads in the first 90 days following its publication in EPL, was a study of the game of go from a complex network perspective.

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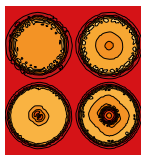
The game of go as a complex network

B. Geogot and O. Giraud

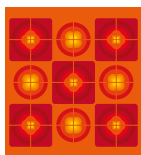
2012 *EPL* **97** 68002

We study the game of go from a complex network perspective. We construct a directed network using a suitable definition of tactical moves including local patterns, and study this network for different datasets of professional and amateur games. The move distribution follows Zipf's law and the network is scale free, with statistical peculiarities different from other real directed networks, such as, e.g., the World Wide Web. These specificities reflect in the outcome of ranking algorithms applied to it. The fine study of the eigenvalues and eigenvectors of matrices used by the ranking algorithms singles out certain strategic situations. Our results should pave the way to a better modelization of board games and other types of human strategic scheming.

EPL subject compilations



Biaxial strain on lens-shaped quantum rings of different inner radii, adapted from **Zhang et al** 2008 *EPL* **83** 67004.



Artistic impression of electrostatic particle-particle interactions in dielectrophoresis, adapted from **N Aubry and P Singh** 2006 *EPL* **74** 623.



Artistic impression of velocity and normal stress profiles around a sphere that moves through a polymer solution, adapted from **R Tuinier, J K G Dhont and T-H Fan** 2006 *EPL* **75** 929.

To ensure that researchers find the articles they need quickly and simply, we publish a series of subject compilations to showcase high-quality articles in specific areas. Each compilation has its own co-editor, who is a leading scientist in that field, and who is responsible for overseeing the review process, selecting referees and making publication decisions for every manuscript to ensure that the very best quality research is published.

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If you are organizing a conference in 2013 and would like EPL to sponsor a prize, please contact the EPL team at **info@epljournal.org**.

Events calendar 2013

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, Dr Graeme Watt, at info@epljournal.org. EPL will have a presence at the following events in 2013 (those marked with an asterisk may be attended by EPL staff members).

Nanometa 2013 Seefeld, Austria, 3–6 January*

International Thin-Film Transistor Conference Tokyo, Japan, 1–2 March*

Optical & Electrical Spectroscopy of Single Quantum Dots Mallorca, Spain, 10–12 March*

DPG Spring Meeting Regensburg, Germany, 10–15 March*

Universal Themes of Bose-Einstein Condensations Leiden, Netherlands, 11–15 March

DPG AMOP Meeting Hannover, Germany, 18–20 March

APS March Baltimore, USA, 18–22 March

AES 2013 (Advanced Electromagnetism Symposium) Sharjah-Dubai, UAE, 19–22 March*

META 2013 (Metamaterials) Sharjah-Dubai, UAE, 18–22 March*

MECO38 Trieste, Italy, 25–27 March

European Rheology Leuven, Belgium, 2–5 April*

Dielectrics 2013 Reading, UK, 10–12 April*

Flavour & CP Violation Rio de Janeiro, Brazil, 20–24 May

E-MRS Spring Strasbourg, France, 27–31 May*

Nordic Physics Days Lund, Sweden, 12–14 June*

Central European Workshop on Quantum Optics Stockholm, Sweden, 16–20 June*

Nordic Semiconductors Aalto, Finland, June

International Conference on Coherent and Nonlinear Optics – Lasers, Applications & Technologies (ICONO-LAT) Moscow, Russia, 18–22 June*

International Conference on Squeezed States and Uncertainty Relations (ICSSUR) Nuremberg, Germany, 24–28 June*

Quantum Information Processing & Computing (QIPC) Florence, Italy, 30 June – 5 July*

EPS Conference on Plasma Physics Espoo, Finland, 1–5 July*

EPS Conference on High Energy Physics Stockholm, Sweden, 18–24 July

IEEE International Symposium on Applications of Ferroelectrics Prague, Czech Republic, 21–25 July*

XXV IUPAP International Conference on Statistical Physics (STATPHYS25) Seoul, Korea, 22–26 July

Turbulent Mixing and Beyond Trieste, Italy, August

Fundamental & Applied Rheology (IBEREO) Malaga, Spain, 4–6 September*

Annual Meeting of the Austrian/Swiss Physical Society Linz, Austria, 4–6 September*

International Soft Matter Rome, Italy, 15–19 September*

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Metamaterials 2013 Bordeaux, France, 16–19 September*

Optics of Liquid Crystals Honolulu, USA, 29 September – 4 October

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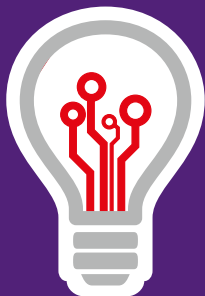
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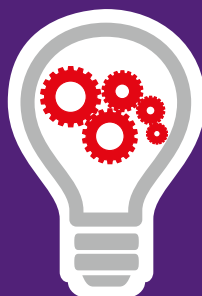
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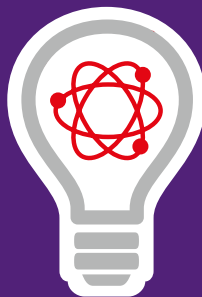
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Synthetic gene networks as potential flexible parallel logic gates (adapted from Hiroyasu Ando *et al* 2012 *EPL* **93** 50001; artistic impression by Frédérique Swist).



Nonlocal mechanism for cluster synchronization in neural circuits (adapted from I. Kanter *et al* 2012 *EPL* **93** 66001; artistic impression by Frédérique Swist).



Surface spin orientation of NiO(100) and interfacial coupling of Fe/NiO(100) revisited with soft X-ray spectromicroscopy (adapted from Suman Mandal *et al* 2012 *EPL* **95** 27006; artistic impression by Frédérique Swist).



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