Potential energy surface for LiNC \( \rightarrow \) LiCN accommodating superscarred wavefunctions (adapted from S D Prado et al 2009 EPL 88 40003; artistic impression by Frédérique Swist).

Sketches of peer-superpeer networks in a simulated ensemble of telechelic polymers (adapted from J Billen et al 2009 EPL 87 68003; artistic impression by Frédérique Swist).

Random walk with movement restricted by boundary conditions (adapted from H Ciftci and M Cakmak 2009 EPL 87 60003; artistic impression by Frédérique Swist).

The shortest spanning tree created from a scale-free network (adapted from A Zeng et al 2009 EPL 87 48002; artistic impression by Frédérique Swist).
Welcome to EPL’s “Best of 2010” Articles Collection

This is the third time that we have compiled journal highlights from the previous year to represent the most popular, interesting and innovative research. Of course, it is not easy to select the best material and so we left the choice to the Co-Editors, the readers and the authors. This collection therefore comprises most of the “Editor’s Choice” articles that were highlighted by the members of the Editorial Board last year; the most downloaded articles, reflecting the interest of the readers; and the most cited papers, demonstrating the appreciation of the authors.

As EPL is a broadband “letters journal exploring the frontiers of physics”, the articles in this collection cover all PACS fields. General physics and condensed-matter papers are more numerous, reflecting the strength of EPL in these areas, in particular in statistical physics and electronic structure calculation.

An additional strength is that EPL belongs to the physicists; it is not owned by a commercial publisher, but rather by a partnership of 17 European physical societies. Nevertheless, it is a truly global journal with a significant number of manuscripts submitted from North America, China and India, as well as developing countries. This globalism is also reflected in the composition of the Editorial Board, which consists of excellent scientists from top institutions across the world. They ensure the quality of EPL, with a rejection rate approaching 60% for submitted manuscripts. It is another strength of EPL that this rigorous peer-review process is the responsibility of scientists.

In 2011 EPL celebrates its 25th anniversary with a symposium on “Frontiers of Physics”. Over these 25 years EPL has matured into an important physics journal. It is now available online and/or in print at more than 1670 institutions worldwide. This broad accessibility, as well as the significant increase of the ISI Impact Factor from about 2.2 (for the previous 10 years) to 2.9 in 2009 shows the esteem with which EPL is regarded by the international physics community. I invite you to join the crowd and to submit your excellent work to EPL.

I would like to thank all our loyal readers, authors, referees, Board Members, Directors and the professional EPL publishing teams in Bologna, Bristol, Mulhouse and Paris, who are vital to the production of this great journal.

Professor Michael Schreiber
Editor-in-Chief
EPL
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Abstract

We have observed the interferometric suspension of a free-falling Bose-Einstein condensate periodically submitted to multiple-order diffraction by a vertical 1D standing wave. This scheme permits simultaneously the compensation of gravity and coherent splitting/recombination of the matter waves. It results in high-contrast interference in the number of atoms detected at constant height. For long suspension times, multiple-wave interference is revealed through a sharpening of the fringes. We characterize our atom interferometer and use it to measure the acceleration of gravity.

PACS numbers: 06.30.Gv, 05.60.Gg, 03.75.Dg

M Robert-de-Saint-Vincent et al 2010 EPL 89 10002

KAM tori in 1D random discrete nonlinear Schrödinger model?

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Abstract

We suggest that KAM theory could be extended for certain infinite-dimensional systems with purely discrete linear spectrum. We provide empirical arguments for the existence of a sum rule over infinitely many discrete tori, which has been verified in an initial condition set of numerical simulations of the 1D random discrete nonlinear Schrödinger equation, with periodic boundary conditions. We observe KAM tori even when the tori are broken by mean-field interactions, in the sense of self-averaging.

PACS numbers: 03.30.+x, 05.45.-a, 42.25.Dd

M Johansson et al 2010 EPL 91 50001

Detrended fluctuation analysis of scaling crossover effects

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Abstract

Detrended fluctuation analysis (DFA) is one of the most frequently used fractal time series algorithms. DFA has also become the tool of choice for analysis of the short-time fluctuations despite the fact that its validity in this domain has never been demonstrated. We adopt an Onslein-Uhlenbeck Langevin equation to generate a time series which exhibits short-time power-law scaling and incorporates the fundamental property of physiological control systems—negative feedback. To determine the scaling exponent, we derive the analytical expressions for the standard deviation of the solution \( X(t) \) of this equation using both the ensemble of statistically independent trajectories and the ensemble obtained by partitioning a single trajectory. The latter approach is used in DFA and many other physiological applications. Surprisingly, the formulas for the standard deviations are different for these two ensembles. We demonstrate that the partitioning amounts to building up deterministic trends that satisfy the “\( \text{trend + signal} \)” decomposition assumption which is characteristic of DFA. Consequently, the dependence of the rms of DFA residuals \( F(\tau) \) on the length \( \tau \) of data window is the same for both ensembles. The growth of \( F(\tau) \) is significantly different from that of the standard deviation \( \sigma(X) \). While the DFA estimate of the short-time scaling exponent is correct, the polynomial detrending delays the approach of \( F(\tau) \) to the asymptotic value by as much as an order of magnitude. This delay may underlie the gradual change of the DFA scaling index typically observed in time series that exhibit crossover between the short- and long-time scaling.

PACS numbers: 87.10.Mn, 05.10.Gg, 05.40.-a

M Ignaccolo et al 2010 EPL 90 10009

About the temperature of moving bodies

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Abstract

Relativistic thermodynamics is constructed from the point of view of special relativistic hydrodynamics. A relativistic four-current for heat and a general treatment of thermal equilibrium between moving bodies are presented. The different temperature transformation formulas of Planck and Einstein, Ott, Landsberg and Doppler appear upon particular assumptions about internal heat current.

PACS numbers: 03.30.+p, 25.75.-q, 05.70.-a

T S Biró and P Ván 2010 EPL 89 30001
Yet another realization of Kerr/CFT correspondence

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Abstract

The correspondence between the Kerr black hole and a boundary CFT has been conjectured recently. The conjecture has been proposed first only for the half of the CFT, namely for left movers. For right movers, the correspondence has been also found out through the suitable asymptotic boundary condition. However, the boundary conditions for these two studies are exclusive to each other. The boundary condition for left movers does not allow the symmetry of right movers, and vice versa. We propose a new boundary condition which allows both left and right movers. The isometries $U(1)$ for the left mover and the $SL(2,R)$ for right mover are enhanced to Virasoro algebras with and without central extensions, respectively.

PACS numbers: 11.25.Tq, 04.20.Ha, 11.25.HF

Yoshinori Matsuo et al 2010 EPL 89 60001

Frustrated quantum antiferromagnetism with ultracold bosons in a triangular lattice

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Abstract

We propose to realize the anisotropic triangular-lattice Bose-Hubbard model with positive tunneling matrix elements by using ultracold atoms in an optical lattice dressed by a fast lattice oscillation. This model exhibits frustrated antiferromagnetism at experimentally feasible temperatures; it interpolates between a classical rotor model for weak interaction, and a frustrated antiferromagnetism at experimental temperatures. We propose to realize the anisotropic triangular-lattice Bose-Hubbard model with positive tunneling matrix elements by using ultracold atoms in an optical lattice dressed by a fast lattice oscillation. This model exhibits frustrated antiferromagnetism. Performing the summation over the entire spectrum of excited states the problem is reduced to the Fredholm determinant with attractive interactions. Performing the summation over the entire spectrum of excited states the problem is reduced to the Fredholm determinant with attractive interactions. Performing the summation over the entire spectrum of excited states the problem is reduced to the Fredholm determinant with attractive interactions.

PACS numbers: 61.41.+e, 05.20.-y, 75.10.Nr

A Eckardt et al 2010 EPL 89 10010

Free-energy distribution of the directed polymer at high temperature

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Abstract

We study the directed polymer of length $t$ in a random potential with fixed endpoints in dimension $1 + 1$ in the continuum and on the square lattice, by analytical and numerical methods. The universal regime of high temperature $T$ is described, upon scaling “time” $t \sim T/\kappa$ and space $x \sim x / \kappa$ (with $\kappa = 7$ for the discrete model) by a continuum model with $\delta$-function disorder correlation. Using the Bethe Ansatz solution for the attractive boson problem, we obtain all positive integer moments of the partition function. The lowest cumulants of the free energy are predicted at small time and found in agreement with numerics. We then obtain the exact expression at any time for the generating function of the free-energy distribution, in terms of a Fredholm determinant. At large time we find that it crosses over to the Tracy-Widom distribution (TW) which describes the fixed-$T$ infinite-$t$ limit. The exact free-energy distribution is obtained for any time and compared with very recent results on growth and exclusion models.

PACS numbers: 05.20.-y, 05.40.-a, 75.10.Nr

P Calabrese et al 2010 EPL 90 20002

Bethe ansatz derivation of the Tracy-Widom distribution for one-dimensional directed polymers

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Abstract

The distribution function of the free-energy fluctuations in one-dimensional directed polymers with $\delta$-correlated random potential is studied by mapping the replicated problem to a many-body quantum boson system with attractive interactions. Performing the summation over the entire spectrum of excited states the problem is reduced to the Fredholm determinant with the Airy kernel which is known to yield the Tracy-Widom distribution.

PACS numbers: 61.41.+e, 05.20.-y, 75.10.Nr

V Dotsenko 2010 EPL 90 20003

On reduced density matrices for disjoint subsystems

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Abstract

We show that spin and fermion representations for solvable quantum chains lead in general to different reduced density matrices if the subsystem is not singly connected. We study the effect for two sites in XX and XY chains as well as for sublattices in XX and transverse Ising chains.

PACS numbers: 75.10.Pq, 03.65.Ud, 03.67.M

F Iglói and I Peschel 2010 EPL 89 40001
Quantum electrodynamics of Casimir momentum: Momentum of the quantum vacuum

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Abstract
The electromagnetic vacuum is known to have energy. It has been recently argued that the quantum vacuum can possess momentum, which adds up to the momentum of matter. This “Casimir momentum” is closely related to the Casimir effect, in which case energy is exchanged. In previous theory it was treated semi-classically. We present a non-relativistic quantum theory for the linear momentum of electromagnetic zero-point fluctuations, considering a harmonic oscillator subject to crossed, quasi-static magnetic and electric and coupled to the quantum vacuum. We derive a contribution to the quantum vacuum to the linear pseudo-momentum and give a new estimate for the achievable speed. Our analysis show that the effect exists and that it is finite.

PACS numbers: 12.20.-m, 03.70.+k, 11.10.Gh

Glueballs and the pomeron

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Abstract
Glueballs are considered to be bound states of constituent gluons. The relativistic wave equation for two massive gluons interacting by the funnel-type potential is analyzed. Using two exact asymptotic solutions of the equation, we derive an interpolating mass formula and calculate glueball masses in agreement with the lattice data. We obtain the complex non-linear Pomeron trajectory, \( \alpha_P(t) \), in the whole region of \( t \). The real part of the trajectory corresponds to the soft pomeron, parameters of which are found from the fit of recent HERA data.


Aspects of diffeomorphism and conformal invariance in classical Liouville theory

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Abstract
The interplay between the diffeomorphism and conformal symmetries (a feature common in quantum field theories) is shown to be exhibited for the case of black holes in two-dimensional classical Liouville theory. We show that although the theory is conformally invariant in the near-horizon limit, there is a breaking of the diffeomorphism symmetry at the classical level. On the other hand, in the region away from the horizon, the conformal symmetry of the theory gets broken with the diffeomorphism symmetry remaining intact.

PACS numbers: 11.10.Nx
Rabin Banerjee et al 2010 EPL 89 11003

Influence of the Lorentz force on the centrality dependence of the kaon flow in heavy-ion collisions

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Abstract
In this letter, the centrality dependence of the collective flow of K⁺-mesons in Ru+Ru reactions at incident energy \( E = 1.69 \) AGeV is studied by using the quantum-molecular-dynamics model within the covariant kaon dynamics. Our calculated results show that the Lorentz force derived from the covariant kaon dynamics obviously influences the features of the centrality dependence of the K⁺ flow in heavy-ion collisions at SIS energies. Without the Lorentz force, the smaller impact parameter gives the weaker in-plane flow and the stronger out-of-plane flow. If the Lorentz force is taken into account, the characteristic of the centrality dependence of \( v_1 \), is appreciably reduced on the magnitude, and property of the centrality dependence of \( v_2 \), is also reduced on the magnitude and even becomes to change its trend that the larger impact parameter gives the stronger out-of-plane flow. For the differential directed flow of K⁺, the same feature as the ones for the \( v_1 \) is obtained. After taking into account the Lorentz force, the theoretical results are considerably reduced, leading to reasonably reproduce the experimental data. This means that the Lorentz force in the covariant kaon dynamics plays an important role in the determination of the collective flow of kaons.

PACS numbers: 25.75.Dw, 24.10.Jv, 25.75.Ld
Yong-Zhong Xing et al 2010 EPL 90 12002
The effect of the tensor force on the predicted stability of superheavy nuclei

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Abstract
The effect of the tensor component of the Skyrme effective nucleon-nucleon interaction on the single-particle structure in superheavy elements is studied. A selection of the available Skyrme forces has been chosen and their predictions for the proton and neutron shell closures investigated. The inclusion of the tensor term with realistic coupling strength parameters leads to a small increase in the spin-orbit splitting between the proton 2f7/2 and 2f5/2 partners, opening the Z=114 shell gap over a wide range of nuclei. The Z=126 shell gap, predicted by these models in the absence of the tensor term, is found to be stongly dependent on neutron number with a Z=138 gap opening for large neutron numbers, having a consequent implication for the synthesis of neutron-rich superheavy elements. The predicted neutron shell structures remain largely unchanged by inclusion of the tensor component.

PACS numbers: 21.30.Fe, 21.60.Jz, 27.90.+b
EPL 2010 EPL 90 12001

Abstract
We examine the energy spectrum of a charged particle in the presence of a non-rotating finite electric dipole. For any value of the dipole moment p above a certain critical value p_c, an infinite series of bound states arises of which the energy eigenvalues obey an Efimov-like geometric scaling law with an accumulation point at zero energy. These properties are largely destroyed in a realistic situation when rotations are included. Nevertheless, our analysis of the idealised case is of interest because it may possibly be realised using quantum dots as artificial atoms.

PACS numbers: 31.15.ae, 31.10.+r
D Schumayer et al 2010 EPL 89 13001

A phonon laser in ultra-cold matter

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Abstract
We show the possible excitation of a phonon laser instability in an ultra-cold atomic gas confined in a magneto-optical trap. Such an effect results from a negative Landau damping of the collective density perturbations in the gas, leading to the coherent emission of phonons. This laser instability can be driven by a blue-detuned laser superimposed to the usual red-detuning laser beams which usually provide the cooling mechanism. Threshold conditions, instability growth rates and saturation levels are derived. This work generalizes, on theoretical grounds, the recent results obtained with a single-ion phonon laser, to an ultra-cold atomic gas, where real phonons can be excited. Future phonon lasers could thus adequately be called phasers.

PACS numbers: 37.10.De, 32.80.Qk, 42.55.-f
J T Mendonça et al 2010 EPL 91 33001

Disordered spherical bead packs are anisotropic

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Abstract
We examine the energy spectrum of a charged particle in the presence of a non-rotating finite electric dipole. For any value of the dipole moment p above a certain critical value p_c, an infinite series of bound states arises of which the energy eigenvalues obey an Efimov-like geometric scaling law with an accumulation point at zero energy. These properties are largely destroyed in a realistic situation when rotations are included. Nevertheless, our analysis of the idealised case is of interest because it may possibly be realised using quantum dots as artificial atoms.

PACS numbers: 31.15.ae, 31.10.+r
D Schumayer et al 2010 EPL 89 13001

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

Geometric scaling in the spectrum of an electron captured by a stationary finite dipole

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Abstract
We examine the energy spectrum of a charged particle in the presence of a non-rotating finite electric dipole. For any value of the dipole moment p above a certain critical value p_c, an infinite series of bound states arises of which the energy eigenvalues obey an Efimov-like geometric scaling law with an accumulation point at zero energy. These properties are largely destroyed in a realistic situation when rotations are included. Nevertheless, our analysis of the idealised case is of interest because it may possibly be realised using quantum dots as artificial atoms.

PACS numbers: 31.15.ae, 31.10.+r
D Schumayer et al 2010 EPL 89 13001
Critical jamming of frictional grains in the generalized isostaticity picture

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Abstract

While frictionless spheres at jamming are isostatic, frictional spheres at jamming are not. As a result, frictional spheres near jamming do not necessarily exhibit an excess of soft modes. However, a generalized form of isostaticity can be introduced if fully mobilized contacts at the Coulomb friction threshold are considered as slipping contacts. We show here that, in this framework, the vibrational density of states (DOS) of frictional discs exhibits a plateau when the generalized isostaticity line is approached. The crossover frequency $\omega^*$ scales linearly with the distance from this line. Moreover, we show that the frictionless limit, which appears singular when fully mobilized contacts are treated elastically, becomes smooth when fully mobilized contacts are allowed to slip. Finally, we elucidate the nature of the vibrational modes, both for slipping and for non-slipping fully mobilized contacts.

PACS numbers: 63.50.-a, 45.70.-n, 46.55.+d

S Henkes et al 2010 EPL 90 14003

Photon orbital angular momentum and mass in a plasma vortex

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Abstract

We analyse the Anderson-Higgs mechanism of photon mass acquisition in a plasma and study the contribution to the mass from the orbital angular momentum acquired by a beam of photons when it crosses a spatially structured charge distribution. To this end we apply Proca-Maxwell equations in a static plasma with a particular spatial distribution of free charges, notably a plasma vortex, that is able to impose orbital angular momentum (OAM) onto light. In addition to the mass acquisition of the conventional Anderson-Higgs mechanism, we find that the photon acquires an additional mass from the OAM and that this mass reduces the Proca photon mass.

PACS numbers: 14.70.Bh, 03.50.De, 52.35.We

F Tamburini et al 2010 EPL 90 45001

Bose-like condensation of Lagrangian particles and higher-order statistics in passive scalar turbulent advection

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Abstract

We establish an hitherto hidden connection between zero modes and instantons in the context of the Kraichnan model for passive scalar turbulent advection, that relies on the hypothesis that the production of strong gradients of the scalar is associated with Bose-like condensation of Lagrangian particles. It opens the way to the computation of scaling exponents of the $N$-th–order structure functions of the scalar by techniques borrowed from many-body theory. To lowest order of approximation, scaling exponents are found to increase asymptotically as $\log N$ in two dimensions.

PACS numbers: 47.27.eb, 02.50.-r

T Dombre 2010 EPL 91 54002

The packing properties of superellipsoids

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Abstract

We investigate the properties of packings of frictionless non-spherical particles utilizing a dynamic particle expansion technique. We employ superquadric particles (superellipsoids), which allows us to explore how a broad range of particle shapes affect both the macroscopic and the local configurational properties of the system. We smoothly transition from spherical particles possessing only translational degrees of freedom to large aspect ratio non-spherical grains where rotational degrees of freedom are highly important. We demonstrate that the degree of anisotropy and local surface curvature of the particles have a profound effect on their packing properties, determining whether a random or an ordered packing is readily formed.

PACS numbers: 61.43.Bn, 45.70.-n, 61.20.-p

G W Delaney and P W Cleary 2010 EPL 89 34002
Electrostatic interactions of charged bodies from the weak- to the strong-coupling regime

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Abstract
A simple field theory approach is developed to model the properties of charged, dielectric bodies and their associated counterions. This predictive theory is able to accurately describe the properties of systems (as compared to computer simulation data) from the weak-coupling limit, where the Poisson-Boltzmann theory works well, through to the strong-coupling limit. In particular, it is able to quantitatively describe the attraction between like-charged plates. In addition, the theory remains accurate even in the presence of dielectric bodies, properly accounting for the influence of image charge interactions. The theory is compared to the strong-coupling expansion, which is found to be applicable only in certain limited situations when dielectric variations are present.

PACS numbers: 05.20.Jj, 61.20.Gy, 52.25.Kn
M M Hatlo and L Lue 2010 EPL 89 25002

60. CONDENSED MATTER: STRUCTURAL, MECHANICAL & THERMAL PROPERTIES

Dynamics of condensation and evaporation: Effect of inter-drop spacing

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Abstract
When studying the condensation of vapor to liquid drops on solid hydrophobic surfaces the volume of drops is found to increase linearly with time, \( V \propto t \). Constant-contact-angle evaporation studies showed that drop volumes decrease according to \( V \propto t^{3/2} \). Since both processes are diffusion limited, one would expect the same kinetics. Here, we demonstrate experimentally and by finite-element simulations that the diffusion limited situations when dielectric variations are present.

PACS numbers: 05.60.Gg, 73.22.F, 64.70.Nd
M Sokuler et al 2010 EPL 89 56003

Sublattice ordering in a dilute ensemble of monovalent adatoms on graphene

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2 Department of Physics, University of Oslo – PO Box 1048 Blindern, N-0316 Oslo, Norway

Abstract
Monovalent adatoms on graphene, they may preferentially take positions on one of its two sublattices, thus breaking the global lattice symmetry. This leads to opening a gap in the electronic spectrum. We show that such a sublattice ordering may spontaneously occur in a low-density ensemble of adatoms adsorbed on graphene, due to the long-range interaction between them mediated by electrons. As a result sublattice-ordered domains may form, with electronic properties characteristic of a two-dimensional topological insulator.

PACS numbers: 05.60.Gg, 73.22.F, 64.70.Nd
V V Cheianov et al 2010 EPL 89 56003

Atomistic simulation of flow-induced crystallization at constant temperature

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Abstract
Semi-crystalline fibers, such as nylon, orlon, and spectra, play a crucial role in modern society in applications including clothing, medical devices, and aerospace technology. These applications rely on the enhanced properties that are generated in these fibers through the orientation and deformation of the constituent molecules of a molten liquid undergoing flow prior to crystallization; however, the atomistic mechanisms of flow-induced crystallization are not understood, and macroscopic theories that have been developed in the past to describe this behavior are semi-empirical. We present here the results of the first successful simulation of flow-induced crystallization at constant temperature using a nonequilibrium Monte Carlo algorithm for a short-chain polyethylene liquid. A phase transition between the liquid and crystalline phases was observed at a critical flow rate in elongational flow. The simulation results quantitatively matched experimental X-ray diffraction data of the crystalline phase. Examination of the configurational temperature generated under flow confirmed for the first time the hypothesis that flow-induced stresses within the liquid effectively raised the crystallization temperature of the liquid.

PACS numbers: 61.20.Ja, 36.20.Ey, 61.20.Gy
C Baig and B J Edwards 2010 EPL 89 36003

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

Incidence of the Tomonaga-Luttinger liquid state on the NMR spin-lattice relaxation in carbon nanotubes

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Abstract
When adsorbents attach themselves to carbons in the honeycomb lattice of graphene, they may preferentially take positions on one of its two sublattices, thus breaking the global lattice symmetry. This leads to opening a gap in the electronic spectrum. We show that such a sublattice ordering may spontaneously occur in a low-density ensemble of adatoms adsorbed on graphene, due to the long-range interaction between them mediated by electrons. As a result sublattice-ordered domains may form, with electronic properties characteristic of a two-dimensional topological insulator.

PACS numbers: 05.60.Gg, 73.22.F, 64.70.Nd
V V Cheianov et al 2010 EPL 89 56003

Incidence of the Tomonaga-Luttinger liquid state on the NMR spin-lattice relaxation in carbon nanotubes

Y Ihara1, P Wzietek1, H Alloul1, M H Rümmel2, Th Pichler2 and F Simon1,3
1 Laboratoire de Physique des Solides, Université Paris-Sud 11, CNRS UMR 8520 – 91405 Orsay, France, EU

Abstract
Semi-crystalline fibers, such as nylon, orlon, and spectra, play a crucial role in modern society in applications including clothing, medical devices, and aerospace technology. These applications rely on the enhanced properties that are generated in these fibers through the orientation and deformation of the constituent molecules of a molten liquid undergoing flow prior to crystallization; however, the atomistic mechanisms of flow-induced crystallization are not understood, and macroscopic theories that have been developed in the past to describe this behavior are semi-empirical. We present here the results of the first successful simulation of flow-induced crystallization at constant temperature using a nonequilibrium Monte Carlo algorithm for a short-chain polyethylene liquid. A phase transition between the liquid and crystalline phases was observed at a critical flow rate in elongational flow. The simulation results quantitatively matched experimental X-ray diffraction data of the crystalline phase. Examination of the configurational temperature generated under flow confirmed for the first time the hypothesis that flow-induced stresses within the liquid effectively raised the crystallization temperature of the liquid.

PACS numbers: 61.20.Ja, 36.20.Ey, 61.20.Gy
C Baig and B J Edwards 2010 EPL 89 36003
Graphene transport at high carrier densities using a polymer electrolyte gate

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5 M Jaiswal and A Pachoud are equal contributors to this work

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\textbf{Abstract}

We report the study of graphene devices in Hall-bar geometry, gated with a polymer electrolyte. High densities of $6 \times 10^{13}$/cm$^2$ are consistently reached, significantly higher than with conventional back-gating. The mobility follows an inverse dependence on density, which can be correlated to a dominant scattering from weak scatterers. Furthermore, our measurements show a Bloch-Grüneisen regime until 100 K (at $6.2 \times 10^{13}$/cm$^2$), consistent with an increase of the density. Ubiquitous in our experiments is a small upturn in resistivity around $3 \times 10^{13}$/cm$^2$, whose origin is discussed. We identify two potential causes for the upturn: the renormalization of Fermi velocity and an electrochemically enhanced scattering rate.

\textbf{PACS numbers: 72.80.Vp, 73.63.-b, 73.40.Mf}

A Pachoud et al\textsuperscript{2010 EPL 92} 27001

Acoustic surface plasmon on Cu(111)

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\textbf{Abstract}

Contrary to previous reports we show that the acoustic surface plasmon (ASP) exists also at noble-metal surfaces, thus demonstrating the generality of this phenomenon in the presence of partially filled Shockley surface states. Angle-resolved high-resolution electron energy loss spectroscopy measurements and calculations of the surface loss function indicate that for Cu(111) the ASP is a sharp feature up to a loss energy of about 0.4 eV. The dispersion is indeed linear (acoustic) with a slope (sound velocity) of $(4.33\pm0.33)$ eV\AA~in good agreement with recent theoretical predictions. The ASP can play important roles down to the meV regime, precluded to ordinary surface plasmons, for electron, phonon and adsorbate dynamics, as well as chemical reactions and advanced microscopies.

\textbf{PACS numbers: 73.20.At, 73.20.Mf, 71.45.Gm}

K Pohl et al\textsuperscript{2010 EPL 92} 57006

Magnon pairing in quantum spin nematic

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\textbf{Abstract}

Competing ferro- and antiferromagnetic exchange interactions may lead to the formation of bound magnon pairs in the high-field phase of a frustrated quantum magnet. With decreasing field, magnon pairs undergo a Bose-condensation prior to the onset of a conventional one-magnon instability. We develop an analytical approach to study the zero-temperature properties of the magnon-pair condensate, which is a bosonic analog of the BCS superconductors. The representation of the condensate wave function in terms of the coherent bosonic states reveals the spin-nematic symmetry of the ground state and allows one to calculate various static properties. Sharp quasiparticle excitations are found in the nematic state with a small finite gap. We also predict the existence of a long-range–ordered spin-nematic phase in the frustrated chain material LiCuVO$_4$ at high fields.

\textbf{PACS numbers: 75.10.Jm, 75.10.Kt, 75.10.Pq}

M E Zhitomirsky and H Tsunetsugu 2010\textsuperscript{EPL 92} 37001
Nonexistence of classical diamagnetism and nonequilibrium fluctuation theorems for charged particles on a curved surface

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Abstract
We show that the classical Langevin dynamics for a charged particle on a closed curved surface in a time-independent magnetic field leads to the canonical distribution in the long time limit. Thus the Bohr-van Leeuwen theorem holds even for a finite system without any boundary and the average magnetic moment is zero. This is contrary to the recent claim by Kumar and Kumar (2009 EPL 86 17001), obtained from numerical analysis of Langevin dynamics, that a classical charged particle on the surface of a sphere in the presence of a magnetic field has a nonzero average diamagnetic moment. We extend our analysis to a many-particle system on a curved surface and show that the nonequilibrium fluctuation theorems also hold in this geometry.

PACS numbers: 75.20.-g, 05.40.-a

Single magnetic molecule between conducting leads: Effect of mechanical rotations

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Abstract
We study spin-rotation effects in a magnetic molecule bridged between two conducting leads. The dynamics of the total angular momentum couples spin tunneling to the mechanical rotations. The Landau-Zener spin transition produced by the time-dependent magnetic field generates a unique pattern of mechanical oscillations that can be detected by measuring the electronic tunneling current through the molecule.

PACS numbers: 85.65.+h, 75.45.+j, 75.50.Xx

Field-induced phase transitions and dielectric energy density in poly(vinylidene fluoride-trifluoroethylene-chlorofluoroethylene) terpolymer

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Abstract
Field-induced polarization, dielectric response and dielectric energy density of poly(vinylidene fluoride-trifluoroethylene-chlorofluoroethylene) terpolymer were investigated. In charging and discharging circles, two dielectric peaks exist at 70 MV/m and 35 MV/m, showing two field-induced phase transitions. The giant electrical energy densities of the terpolymer should be attributed to the rapid change of polarization in the field-induced ferroelectric phase.

PACS numbers: 77.22.Ej, 77.80.-e, 77.84.Jd
Lei Zhang 2010 EPL 91 47001

Optical properties of BaFe2–xCoxAs2

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Abstract
We present detailed temperature-dependent optical data on BaFe2–xCoxAs2 (BCFA), with x = 0.14, between 4 meV and 6.5 eV. We analyze our spectra to determine the main optical parameters and show that in this material the interband conductivity already starts at energies as low as 10 meV. We determine the superfluid density \( \rho_s/\left(2\pi c^2\right) = 2.2 \pm 0.5 \times 10^{10} \text{ cm}^{-2} \), which places optimally doped BFCA close to the Uemura line. Our experimental data shows clear signs of a superconducting gap with \( 2\Delta_1 = 6.2 \pm 0.8 \text{ meV} \). In addition, from comparing the experimental spectra to model calculations we obtain indications for an additional band of strongly scattered carriers with a larger gap, \( 2\Delta_2 = 14 \pm 2 \text{ meV} \).

PACS numbers: 74.25.-q, 74.70.Xa, 74.25.Gz
E van Heumen et al 2010 EPL 90 37005
Spin relaxation due to random Rashba spin-orbit coupling in GaAs (110) quantum wells

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Abstract
We investigate the spin relaxation due to the random Rashba spin-orbit coupling in symmetric GaAs (110) quantum wells from the fully microscopic kinetic spin Bloch equation approach. All relevant scatterings, such as the electron-impurity, electron–longitudinal-optical-phonon, electron–acoustic-phonon, as well as electron-electron Coulomb scatterings are explicitly included. It is shown that our calculation reproduces the experimental data by Müller et al. (2008 Phys. Rev. Lett. 101 206601) for a reasonable choice of parameter values. We also predict that the temperature dependence of the spin relaxation time presents a peak in the case with low impurity density, which originates from the electron-electron Coulomb scattering.

PACS numbers: 71.10.-w, 71.70.Ej, 72.25.Rb

Y Zhou and M W Wu 2010 EPL 89 57001

Droplet-like Fermi surfaces in the anti-ferromagnetic phase of EuFe2As2, an Fe-pnictide superconductor parent compound

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Abstract
One of the unifying concepts in the iron-pnictide superconductors, both for the mechanism of magnetic ordering and of unconventional order parameter character, has been the electron and hole Fermi surfaces that are approximately nested. Using the density functional methods that have predicted Fermi surfaces correctly in SrFe2P2, we find that the recently reported superconducting Sr2VO3FeAs, with $T_c$=37 K and no apparent competition between magnetism and superconductivity, possesses different Fermi surface geometry and character than previous classes of iron pnictides. The intervening layer (a V bilayer) gives rise to bands that cross the Fermi level. Coupling to the FeAs layer is small except for interaction along the zone boundary, however that coupling degrades the Fermi surface nesting. Sr2VO3FeAs, with its alternating layers of open-shell atoms, deserves further close study that should help to understand the origin of the properties of iron pnictide compounds.

PACS numbers: 74.20.Pq, 74.70.Xa, 71.18.+y

K-W Lee and W E Pickett 2010 EPL 89 57008

Aharonov-Bohm effect in undoped graphene: Magnetotransport via evanescent waves

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Abstract
Using conformal mapping technique, compact and general analytic expressions for the effects of magnetic fluxes on conductance and Fano factor of undoped graphene nanoflakes in pseudodiffusive regime are derived.

PACS numbers: 73.23.Ad, 03.65.Pm, 72.80.Vp

Sr2VO3FeAs: A nanolayered bimetallic iron pnictide superconductor

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Abstract
Using angle-resolved photoemission it is shown that the low-lying electronic states of the iron pnictide parent compound EuFe2As2, are strongly modified in the magnetically ordered, low-temperature, orthorhombic state compared to the tetragonal, paramagnetic case above the spin density wave transition temperature. Back-folded bands, reflected in the orthorhombic/anti-ferromagnetic Brillouin zone boundary hybridize strongly with the non-folded states, leading to the opening of energy gaps. As a direct consequence, the large Fermi surfaces of the tetragonal phase fragment, the low-temperature Fermi surface being composed of small droplets, built up of electron- and hole-like sections. These high-resolution ARPES data are therefore in keeping with quantum oscillation and optical data from other undoped pnictide parent compounds.

PACS numbers: 74.20.Pq, 74.70.Xa, 71.18.+y

K-W Lee and W E Pickett 2010 EPL 89 57008

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Angoricty and compactivity describe the jamming transition in soft particulate matter

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Abstract

The application of concepts from equilibrium statistical mechanics to out-of-equilibrium systems has a long history of describing diverse systems ranging from glasses to granular materials. For dissipative jammed systems—particulate grains or droplets— a key concept is to replace the energy ensemble describing conservative systems by the volume-stress ensemble. Here, we test the applicability of the volume-stress ensemble to describe the jamming transition by comparing the jammed configurations obtained by dynamics with those averaged over the ensemble as a probe of ergodicity. Agreement between both methods suggests the idea of “thermalization” at a given angoricty and compactivity. We elucidate the thermodynamic order of the jamming transition by showing the absence of critical fluctuations in static observables like pressure and volume. The approach allows to calculate observables such as the entropy, volume, pressure, coordination number and distribution of forces to characterize the scaling laws near the jamming transition from a statistical mechanics viewpoint.

PACS numbers: 81.05.Rm
Kun Wang et al 2010 EPL 91 68001

Cyclic competition of four species: Mean field theory and stochastic evolution

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Abstract

Generalizing the cyclically competing three-species model (often referred to as the rock-paper-scissors game), we consider a simple system of population dynamics without spatial structures that involves four species. Unlike the previous model, the four form alliance pairs which resemble partnership in the game of Bridge. In a finite system with discrete stochastic dynamics, all but 4 of the absorbing states consist of coexistence of a partner-pair. From the mean-field point of view, we derive a set of mean-field equations of evolution. This approach predicts complex time dependence of the system and that the surviving partner-pair is the one with the larger product of their strengths (rates of consumption). Simulations typically confirm these scenarios. Beyond that, much richer behavior is revealed, including complicated extinction probabilities and non-trivial distributions of the population ratio in the surviving pair. These discoveries naturally raise a number of intriguing questions, which in turn suggests a variety of future avenues of research, especially for more realistic models of multispecies competition in nature.

PACS numbers: 87.23.Cc, 02.50.Ey, 05.40.-a
S O Case et al 2010 EPL 92 58003

Soccer: Is scoring goals a predictable Poissonian process?

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Abstract

The non-scientific event of a soccer match is analysed on a strictly scientific level. The analysis is based on the recently introduced concept of a team fitness (2009 Eur. Phys. J. B 67 445) and requires the use of finite-size scaling. A uniquely defined function is derived which quantitatively predicts the expected average outcome of a soccer match in terms of the fitness of both teams. It is checked whether temporary fitness fluctuations of a team hamper the predictability of a soccer match. To a very good approximation scoring goals during a match can be characterized as independent Poissonian processes with pre-determined expectation values. Minor correlations give rise to an increase of the number of draws. The non-Poissonian overall goal distribution is just a consequence of the fitness distribution among different teams. The limits of predictability of soccer matches are quantified. Our model-free classification of the underlying ingredients determining the outcome of soccer matches can be generalized to different types of sports events.

PACS numbers: 02.50.-o, 89.20.-a
A Heuer et al 2010 EPL 99 38007

The extensive nature of group quality

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Abstract

We consider groups of interacting nodes engaged in an activity as many-body, complex systems and analyse their cooperative behaviour from a mean-field point of view. We show that inter-nodal interactions rather than accumulated individual node strengths dominate the quality of group activity, and give rise to phenomena akin to phase transitions, where the extensive relationship between group quality and quantity reduces. The theory is tested using empirical data on the quantity and quality of scientific research groups, for which critical masses are determined.

PACS numbers: 05.65.+b, 01.75.+m, 89.75.-k
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Jamming of polydisperse hard spheres: The effect of kinetic arrest

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1. The glass transition

1.1. Jammed state

1.2. Hard sphere model

1.3. Jamming transition

2. The mean-field theory

2.1. General result

2.2. Poissonian processes

2.3. Non-Poissonian conditions

2.4. Dynamical variables

3. The continuous transition

3.1. Non-universal corrections to the scaling laws

3.2. Phase transition

4. The random kinetic model

4.1. Temporal correlations

4.2. Analytical approach

4.3. Markovian approximation

4.4. Numerical analysis

5. Monte Carlo simulations

5.1. Static variables

5.2. Dynamic variables

5.3. Summary

6. Conclusion

EPL: BEST OF 2010
**Abstract**
We study jammed configurations of polydisperse colloidal hard spheres with a well-defined temperature (constant kinetic energy) as a function of compression speed and size polydispersity. To this end, we employ event-driven molecular-dynamics simulations at fixed temperature, using an algorithm that strictly prohibits particle overlaps. We find a strong dependence of the jamming density on the compression rate that cannot be explained by crystallization. Additionally, we find that during the compression, the pressure follows the metastable liquid branch until the system gets kinetically arrested. Our results show that further compression yields jammed configurations that can be regarded as the infinite-pressure limit of glassy states and that different glasses can jam at different jamming densities depending on the compression rate. We present accurate data for the jamming density as a function of compression rate and size polydispersity.

**PACS numbers:** 64.70.Q, 82.70.Dd, 61.43.Fs

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**Can the Tajmar effect be explained using a modification of inertia?**

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**Abstract**
The Tajmar effect is an unexplained acceleration observed by accelerometers and laser gyroscopes close to rotating supercooled rings. The observed ratio between the gyroscope and ring accelerations was $3 \pm 1.2 \times 10^{-8}$. Here, a new model for inertia which has been tested quite successfully on the Pioneer and flyby anomalies is applied to this problem. The model assumes that the inertia of the gyroscope is caused by Unruh radiation that appears as the ring and the fixed stars accelerate relative to it, and that this radiation is subject to a Hubble-scale Casimir effect. The model predicts that the sudden acceleration of the nearby ring causes a slight increase in the inertial mass of the gyroscope, and, to conserve momentum in the reference frame of the spinning Earth, the gyroscope rotates clockwise with an acceleration ratio of $1.78 \pm 0.25 \times 10^{-8}$ in agreement with the observed ratio. However, this model does not explain the parity violation seen in some of the gyroscope data. To test these ideas the Tajmar experiment (setup B) could be exactly reproduced in the Southern Hemisphere, since the model predicts that the anomalous acceleration should then be anticlockwise.

**PACS numbers:** 06.30.Gv, 95.30.-k, 45.20.df

M E McCulloch 2010 EPL 89 19001

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**Tachyonic spectral fits of γ-ray bursts**

**R Tomaschitz**

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**Abstract**
Evidence for superluminal radiation in γ-ray burst (GRB) spectra is pointed out. The spectral maps of GRB 941017, GRB 990123, and GRB 990104 are analyzed. The superluminal radiation modes are generated by the shock-heated ultra-relativistic source plasma. The tachyonic radiation field is a real Proca field with negative mass-square, coupled to the electron gas by a frequency-dependent fine-structure constant. At GeV energies, the coupling constant approaches a limit value, so that the radiation field is minimally coupled to the electron current. In the soft γ-ray band, the interaction with the GRB plasma becomes nonlocal, due to the varying coupling strength depending on the energy of the radiated modes. The spectral fitting with tachyonic flux densities generated by nonlocal plasma currents is explained. Estimates of the tachyonic luminosity, temperature, and internal energy of the electronic source plasma are obtained from the spectral fits.

**PACS numbers:** 98.70.Rz, 95.30.Gv, 52.27.Ny

R Tomaschitz 2010 EPL 89 39002
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