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Highlights of 2013

The climate of scholarly publishing is shifting rapidly. Funding bodies and governments are making commitments to open access publishing, and most research is now read online rather than in printed journal copies. Leading the community, *New Journal of Physics* (NJP) has been publishing high-quality research across the whole of physics, under a 'gold' open access model (http://iopscience.iop.org/1367-2630/page/Article%20charge) , for over fifteen years.

During this time, we have seen articles evolve from simple PDF files to include enhanced HTML functionality (http://iopscience.iop.org/info/page/articleevolution) with download and citation tracking, as well as the increased inclusion of additional article content such as our video abstracts (http://iopscience.iop.org/1367-2630/videoabstracts) . As an interdisciplinary journal with broad appeal, our general scientific summaries (http://iopscience.iop.org/1367-2630/page/General scientific summaries) have also become a popular way to introduce work to a more general audience, and over the past year many articles have been featured by international news organisations.

In 2014, to better serve the needs of all our authors and readers, NJP is introducing a new article type to prioritise the best of its content in the most rapidly evolving fields. Fast Track Communications (http://iopscience.iop.org/1367-2630/page/Fast%20Track%20Communications) will represent the highest-quality material to be published in the journal and will be given priority peer review and publication to ensure that they reach our readers as quickly as possible.

NJP's status as a leading open access physics journal was reaffirmed recently with its inclusion as one of only 10 journals approved for SCOAP^3 funding (http://scoap3.org/) of research in high-energy particle physics. We're very excited to have been recognised as an important conduit for this community.

With more than 1.5 million free downloads of our articles and an impact factor above four again, 2013 has been another great year for the journal. We wish to acknowledge that the success of the journal is due entirely to the fantastic support of authors and readers like you. On behalf of the Institute of Physics (http://www.iop.org) and the Deutsche Physikalische Gesellschaft (http://www.dpg-physik.de/index.html) , we would like to thank you for your vital contribution to *New Journal of Physics*.

Below, we present a sample of the excellent research published during 2013 and we invite you to browse this interesting collection. We hope that we are able to feature your work in our Highlights next year.

Professor Dr Eberhard Bodenschatz,
Professor of Physics,
Director at the Max Planck Institute for Dynamics and Self-Organization,
Editor-in-Chief

- Highlights of 2012 (http://iopscience.iop.org/1367-2630/page/Highlights%20of%202012)
- Highlights of 2011 (http://iopscience.iop.org/1367-2630/page/Highlights%20of%202011)

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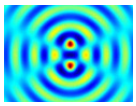


Optics and imaging Show article list

Optics has been a fantastic subject for both fundamental and applied science. Here is a selection of six groundbreaking and fun papers that we published this year in optics and wave physics.

Aharonov *et al* showed how different a seemingly simple experiment is perceived in both the classical and quantum worlds: the bouncing of light off a mirror in an interferometer seems intuitively understandable for light waves, but appears totally bizarre for light quanta. Hidden quantum weirdness is revealed.

Wisniewski-Barker *et al* demonstrated in a beautifully simple experiment that a crystal of ruby is able to delay and drag light. They illuminated a rotating ruby crystal and showed that the light rotates with it. Seeing is believing.

In another beautifully simple experiment, Waselikowski *et al* demonstrated that a simple metallic disk concentrates terrahertz radiation to a tiny spot if the radiation is radially polarized. Spot-on.

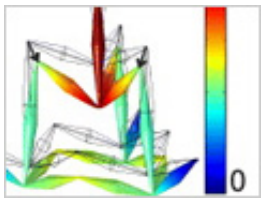
The localization of waves in random media – the idea that waves get stuck in a random environment – has been a paradigm of condensed matter physics. A simple experiment with optical waveguides demonstrates the limits of this paradigm. Optics shows the way out.

In an as yet theoretical paper, Chen *et al* predict how transformation optics can almost magically transform several light sources into one and vice versa. Like in Goethe's *Hexeneinmaleins*: Understand this, then! From one make ten.

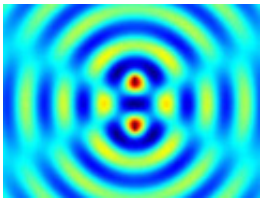
Inspired by transformation optics, Kadic *et al* designed lattices of mechanical structures that behave like liquids that do not flow away. Moreover, these meta-liquids are anisotropic: the speed of elastic waves depends on their propagation directions. Shear fantastic!

Professor Ulf Leonhardt, Weizmann Institute of Science

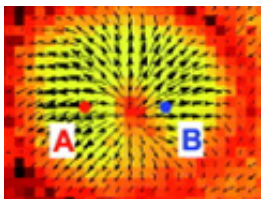
Evidence of slow-light effects from rotary drag of structured beamsEmma Wisniewski-Barker, Graham Gibson, Sonja Franke-Arnold, Zhimin Shi, Robert W Boyd and Miles J Padgett2013 *New J. Phys.* **15** 083020



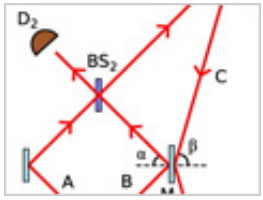
On anisotropic versions of three-dimensional pentamode metamaterialsMuamer Kadic, Tiemo Bückmann, Robert Schittny and Martin Wegener2013 *New J. Phys.* **15** 023029



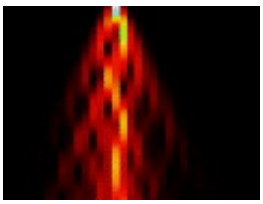
Playing the tricks of numbers of light sourcesHuanyang Chen, Yadong Xu, Hui Li and Tomáš Tyc2013 *New J. Phys.* **15** 093034



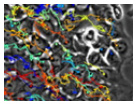
Optimal plasmonic focusing on a metal disc under radially polarized terahertz illuminationStefan Waselikowski, Christian Fischer, Jan Wallauer and Markus Walther2013 *New J. Phys.* **15** 075005



The classical limit of quantum optics: not what it seems at first sightYakir Aharonov, Alonso Botero, Shmuel Nussinov, Sandu Popescu, Jeff Tollaksen and Lev Vaidman2013 *New J. Phys.* **15** 093006



Experimental observation of superdiffusive transport in random dimer latticesU Naether, S Stützer, R A Vicencio, M I Molina, A Tünnermann, S Nolte, T Kottos, D N Christodoulides and A Szameit2013 *New J. Phys.* **15** 013045



Soft matter and biophysics Show article list

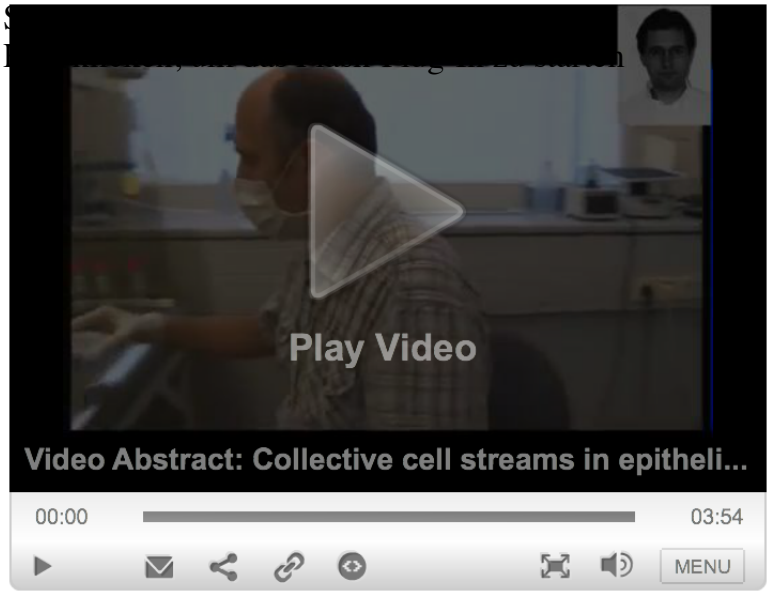
We understand how order emerges in equilibrium systems through collective effects, most prominently at phase transitions, but what outcomes can be expected in active systems with autonomous agents? Physicists are increasingly investigating this question in medically highly relevant systems, such as collectives of cancer cells or bacteria. Collective modes of motion can also be found in groups of animals, for example in penguin huddles.

Investigating single cells with methods and concepts from soft matter physics has remained a major research activity also in the year 2013. For example, Kristal-Muscal *et al* (http://iopscience.iop.org/1367-2630/15/3/035022) used polyacrylamide gels to show that metastatic cancer cells tend to invade soft substrates using their nucleus as a battering ram, and Banerjee and Marchetti (http://iopscience.iop.org/1367-2630/15/3/035015) used a contractile film model to show how traction stress of adherent cells can be controlled by micropatterned substrates. As the field of single cell biophysics matures, however, it becomes increasingly realistic to also investigate collective behaviour in such active systems.

One instructive example of such a study is the one by Lee *et al* (http://iopscience.iop.org/1367-2630/15/2/025036) , who used image processing to track the flow field of an epithelial cells sheet. They find that the flow behaviour becomes more plastic at higher densities, in marked contrast to inanimate systems. For another epithelial system, Czirók *et al* (http://iopscience.iop.org/1367-2630/15/7/075006) found that decreasing cell–cell adhesion induces narrower and more anisotropic cell streams, in very good agreement with computer simulations with a cellular Potts model and reminiscent of decreasing the Taylor scale of turbulent liquids.

Collectives of migrating epithelial cells are a well established model system for cancer metastasis, which is increasingly investigated by physicists. Another model system of large medical relevance are collectives of bacteria. Ryan *et al* (http://iopscience.iop.org/1367-2630/15/10/105021) combined experiments and simulations to identify the collective modes of motion in dense suspensions of *Bacillus subtilis*. On surfaces, bacteria often form so-called biofilms, which are a major cause for infections of patients or clogging of pipes. A fast-growing research effort is under-way to study them from the physics point of view. For example, Epstein *et al* (http://iopscience.iop.org/1367-2630/15/9/095018) used stretchable elastic substrates to demonstrate how biofilms can be reduced by mechanical strain.

The physics of collective phenomena applied to active systems does not stop at the tissue level, but is also relevant to animal populations, e.g. to schools of fish or flocks of birds. Drawing from earlier lessons on cells for image analysis, Gerum *et al* (http://iopscience.iop.org/1367-2630/15/12/125022) have used video films taken in the Antartic winter to study how travelling waves emerge in emperor penguin huddles. Using a simple computational model, they show that the observed waves develop when single penguins try to keep a close distance to their neighbours in order to profit from its body heat. The propagation of the resulting wave resembles similar phenomena in other jammed systems, such as flowing sand or car traffic.



Collective cell streams in epithelial monolayers depend on cell adhesionAndrás Czirók, Katalin Varga, Előd Méhes and András Szabó2013 *New J. Phys.* **15** 075006

Correlation properties of collective motion in bacterial suspensionsShawn D Ryan, Andrey Sokolov, Leonid Berlyand and Igor S Aranson2013 *New J. Phys.* **15** 105021

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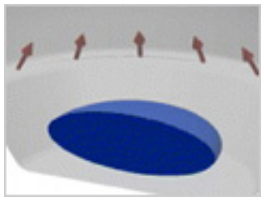
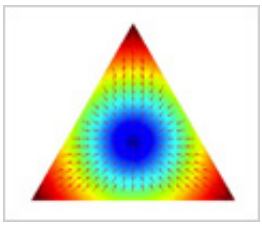
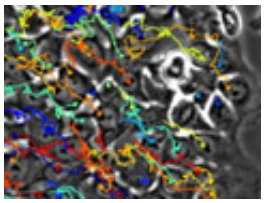
The origin of traveling waves in an emperor penguin huddleR C Gerum, B Fabry, C Metzner, M Beaulieu, A Ancel and D P Zitterbart2013 *New J. Phys.* **15** 125022



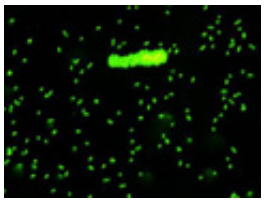
Metastatic cancer cells tenaciously indent impenetrable, soft substratesR Kristal-Muscal, L Dvir and D Weihs2013 *New J. Phys.* **15** 035022



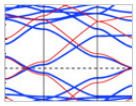
Controlling cell–matrix traction forces by extracellular geometryShiladitya Banerjee and M Cristina Marchetti2013 *New J. Phys.* **15** 035015



Quantifying stretching and rearrangement in epithelial sheet migrationRachel M Lee, Douglas H Kelley, Kerstin N Nordstrom, Nicholas T Ouellette and Wolfgang Losert2013 *New J. Phys.* **15** 025036



Biofilm attachment reduction on bioinspired, dynamic, micro-wrinkling surfacesAlexander K Epstein, Donggyoon Hong, Philseok Kim and Joanna Aizenberg2013 *New J. Phys.* **15** 095018



Condensed matter Show article list

2013 saw a number of important new developments in exotic low-dimensional systems and topological states of matter, possibly the topics of greatest current interest in condensed matter physics.

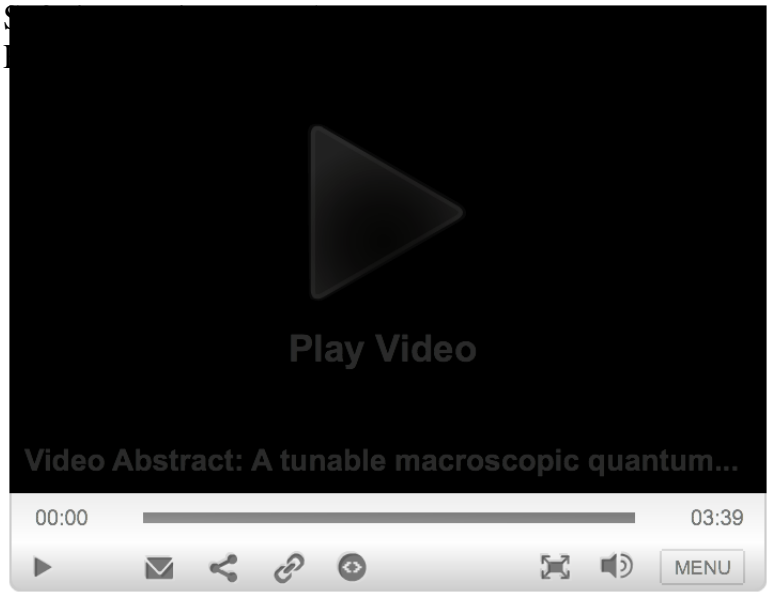
The search for Majorana fermions continued, with the observation of annihilation of two quasiparticles at the end of a nanowire coupled to superconducting leads, and new theoretical proposals how to realize Majoranas. One suggests that topological superconductivity and Majorana end states can be realized in a chain of magnetic impurities on the surface of an s-wave superconductor when the magnetic moments form a spin helix as a result of the RKKY interaction mediated by the superconducting substrate; a second proposes that similar states may be prepared with 1D arrays of quantum dots, and a third, the possibility of using ultracold atomic Fermi gases.

Novel states in Fe-based superconductors, particularly ultrathin films of chalcogenide systems were of wide interest. The graphene field continued its push outward, with the study of a variety of new systems based on graphene and honeycomb lattices, including graphynes and bilayer systems. Finally, an old prediction was finally verified by the conclusive observation of the chirality of a superfluid ^{3}He-A thin film.

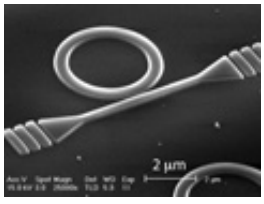
Realizations of quantum simulators of condensed matter systems was also a subject of intense study. As an example, last year's results showed the possibility of exploring the honeycomb lattice geometry, both in exciton-polariton and in ultracold atomic systems. Particularly appealing is the possibility to tune interactions, and apply suitably engineered “synthetic” magnetic fields. These new systems are very promising for exploring novel quantum phases and non-trivial topological order.

Dr Anna Minguzzi, CNRS, Grenoble and Professor Peter Hirschfeld, University of Florida

Mapping gigahertz vibrations in a plasmonic–phononic crystalTimothy A Kelf, Wataru Hoshii, Paul H Otsuka, Hirotaka Sakuma, Istvan A Veres, Robin M Cole, Sumeet Mahajan, Jeremy J Baumberg, Motonobu Tomoda, Osamu Matsuda and Oliver B Wright2013 *New J. Phys.* **15** 023013

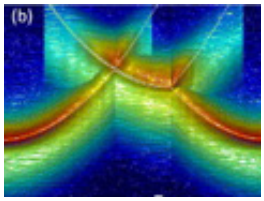


A tunable macroscopic quantum system based on two fractional vorticesD M Heim, K Vogel, W P Schleich, D Koelle, R Kleiner and E Goldobin2013 *New J. Phys.* **15** 053020



Quantum photonic devices in single-crystal diamondAndrei Faraon, Charles Santori, Zhihong Huang, Kai-Mei C Fu, Victor M Acosta, David Fattal and Raymond G Beausoleil2013 *New J. Phys.* **15** 025010

Exciton–polariton condensates near the Dirac point in a triangular latticeN Y Kim, K Kusudo, A Löffler, S Höfling, A Forchel and Y Yamamoto2013 *New J. Phys.* **15**



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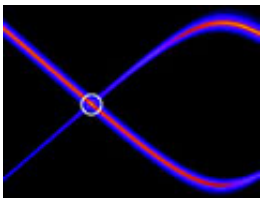
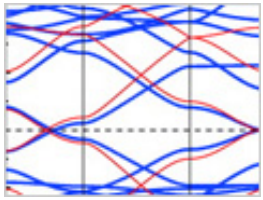
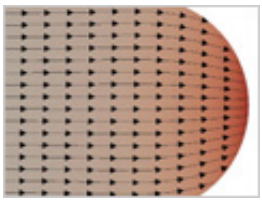


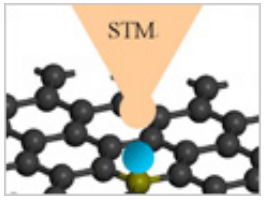
Adaptive tuning of Majorana fermions in a quantum dot chainIon C Fulga, Arbel Haim, Anton R Akhmerov and Yuval Oreg2013 *New J. Phys.* **15** 045020



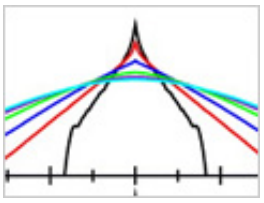
The existence/absence of Dirac cones in graphynesHuaqing Huang, Wenhui Duan and Zhirong Liu2013 *New J. Phys.* **15** 023004



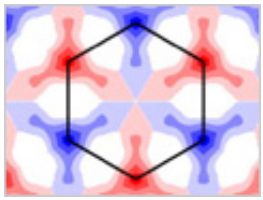
Chiral nature of magnetic monopoles in artificial spin iceN Rougemaille, F Montaigne, B Canals, M Hehn, H Riahi, D Lacour and J-C Toussaint2013 *New J. Phys.* **15** 035026



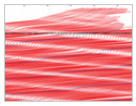
The Kondo effect of an adatom in graphene and its scanning tunneling spectroscopyLin Li, Yang-Yang Ni, Yin Zhong, Tie-Feng Fang and Hong-Gang Luo2013 *New J. Phys.* **15** 053018



Coherent quantum transport in disordered systems: I. The influence of dephasing on the transport properties and absorption spectra on one-dimensional systemsJeremy M Moix, Michael Khasin and Jianshu Cao2013 *New J. Phys.* **15** 085010



Measuring topology in a laser-coupled honeycomb lattice: from Chern insulators to topological semi-metalsN Goldman, E Anisimovas, F Gerbier, P Öhberg, I B Spielman and G Juzeliūnas2013 *New J. Phys.* **15** 013025



Complex networks and statistical physics Show article list

The realm of complex systems' physics is rapidly expanding and now joins statistical mechanics with nonlinear dynamics and what is currently becoming “network science” to further our understanding of collective phenomena in nonlinearly interacting, high-dimensional systems. Recent results elaborate modern concepts and bring in new ideas at

an accelerating pace, from theoretical foundations on non-equilibrium systems and network dynamics to modern applications such as in cloud turbulence and traffic flow.

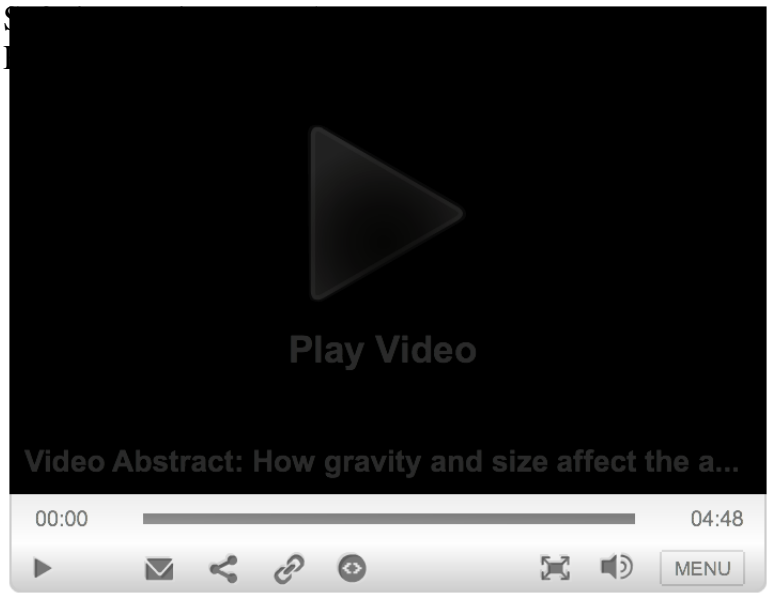
Accordingly, the 2013 Boltzmann Medal for ground-breaking achievements in statistical physics has been awarded to Giovanni Jona-Lasinio for fundamental theoretical contributions on symmetry breaking and non-equilibrium extensions of thermodynamics and to Harry Swinney for bringing together experiments and theory on how instabilities and nonlinearities shape non-equilibrium phenomena. Many 2013 contributions to *New Journal of Physics* also highlight the importance of links between theory and experiments, between nonlinear or network dynamics and statistical mechanics, as well as between conceptual foundations and applications.

For instance, in a theoretical *tour de force*, Gaspard (http://iopscience.iop.org/1367-2630/15/11/115014) established multivariate fluctuation relations for systems that are open and in contact with more than one reservoir, linking to the second law of thermodynamics for equilibrium systems. Both theoretical and experimental model studies can now be built on these cornerstone results. One study, Comin *et al* (http://iopscience.iop.org/1367-2630/15/1/013048) , quantifies how far local unit dynamics in a nonlinear interaction network is distinct from the overall dynamics and how that depends on the networks' interconnectivity. Visser (http://iopscience.iop.org/1367-2630/15/4/043021) identifies basic principles that generate power law distributions based on entropy maximization – or making a choice using the least information.

The sling effect, which describes how weakly inertial particles move through highly intermittent turbulent gas flows, has now been observed in experiments with unprecedented resolution (http://iopscience.iop.org/1367-2630/15/8/083051) and a theoretically generated hypothesis on phase transitions from traffic flow to traffic jams (http://iopscience.iop.org/1367-2630/15/10/103034) has been established experimentally for the first time.

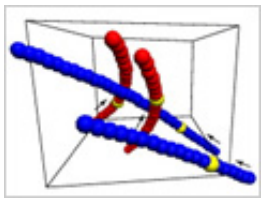
Some other fascinating articles emphasizing strong recent progress and a clearly growing trend towards modern complex systems' physics are listed below.

Professor Dr Marc Timme, Max-Planck Institute for Dynamics and Self-Organization

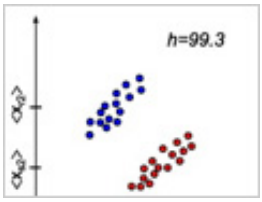


How gravity and size affect the acceleration

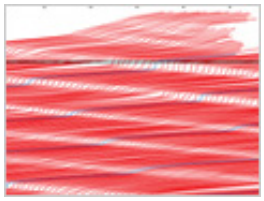
statistics of bubbles in turbulenceVivek N Prakash, Yoshiyuki Tagawa, Enrico Calzavarini, Julián Martínez Mercado, Federico Toschi, Detlef Lohse and Chao Sun2012 *New J. Phys.* **14** 105017



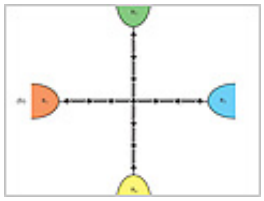
Observation of the sling effectGregory P Bewley, Ewe-Wei Saw and Eberhard Bodenschatz2013 *New J. Phys.* **15** 083051



The relationship between structure and function in locally observed complex networksCesar H Comin, Matheus P Viana and Luciano da F Costa2013 *New J. Phys.* **15** 013048

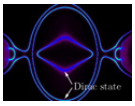


Phase transition in traffic jam experiment on a circuitShin-ichi Tadaki, Macoto Kikuchi, Minoru Fukui, Akihiro Nakayama, Katsuhiro Nishinari, Akihiro Shibata, Yuki Sugiyama, Taturu Yosida and Satoshi Yukawa2013 *New J. Phys.* **15** 103034



Multivariate fluctuation relations for currentsPierre Gaspard2013 *New J. Phys.* **15** 115014

Zipf's law, power laws and maximum entropyMatt Visser2013 *New J. Phys.* **15** 043021

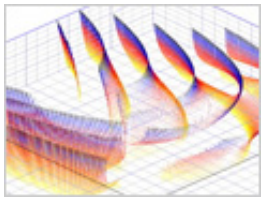


Surface science and thin films Show article list

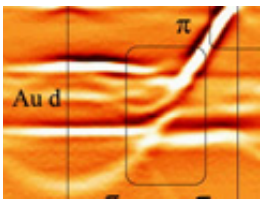
Spin Textures at Interfaces
The spin-orbit interaction in a lattice lacking inversion symmetry leads to antisymmetric exchange interactions that depend on the cross product of neighbouring spin vectors rather than the more commonly considered scalar product. In bulk crystals this *Dzyaloshinskii-Moriya (DM) interaction* leads, for example, to diverse spin spiral magnetic structures, swirling topological spin defects called skyrmions, and unusual macroscopic properties such as coupling between applied electric fields and magnetization. The past decade has shown that related effects are often relevant at surfaces and interfaces, where inversion symmetry is always broken and the atomic spin-orbit interaction can be seriously modified by the electron propagation in the interfacial electric field, the so-called Rashba interaction. Particularly in the past few years it has become apparent that antisymmetric exchange at magnetic interfaces can lead to a rich variety of chiral ground states with periodicities ranging from nanometres to microns. Some of these phases are proposed for low power

spintronic applications. Two papers in NJP in the past year explore this kind of physics in systems with Dirac cones in their band structures. Shikin *et al* (http://iopscience.iop.org/1367-2630/15/1/013016/) , show how to modify the effective spin-orbit interaction in graphene layers on a magnetic substrate, which is a big step towards injecting antisymmetric exchange into this important system. Mirhosseini *et al* (http://iopscience.iop.org/1367-2630/15/3/033019) , provide a detailed theoretical model of a Dirac-cone-like surface band with a topological spin texture observed on a W(110) surface. That surface has long been a model substrate for thin film systems and we can anticipate interesting thin film spin phases in the future.

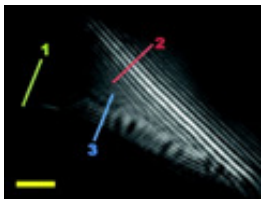
Professor Steve Kevan, Lawrence Berkeley National Laboratory



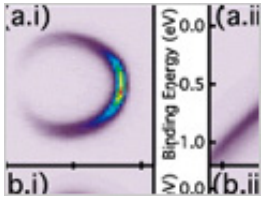
Sorting the modes contributing to guidance in strain-induced graphene waveguidesCesar E P Villegas, Marcos R S Tavares, G-Q Hai and F M Peeters2013 *New J. Phys.* **15** 023015



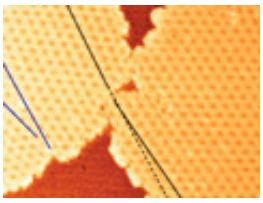
Induced spin–orbit splitting in graphene: the role of atomic number of the intercalated metal and π–d hybridizationAlexander M Shikin, Artem G Rybkin, Dmitry Marchenko, Anna A Rybkina, Markus R Scholz, Oliver Rader and Andrei Varykhalov2013 *New J. Phys.* **15** 013016



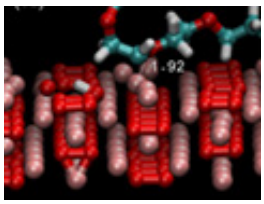
Nanoscale structuring of tungsten tip yields most coherent electron point-sourceJosh Y Mutus, Lucian Livadaru, Radovan Urban, Jason Pitters, A Peter Legg, Mark H Salomons, Martin Cloutier and Robert A Wolkow2013 *New J. Phys.* **15** 073038



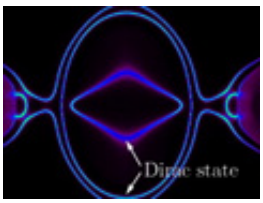
Small scale rotational disorder observed in epitaxial graphene on SiC(0001)Andrew L Walter, Aaron Bostwick, Florian Speck, Markus Ostler, Keun Su Kim, Young Jun Chang, Luca Moreschini, Davide Innocenti, Thomas Seyller, Karsten Horn and Eli Rotenberg2013 *New J. Phys.* **15** 023019



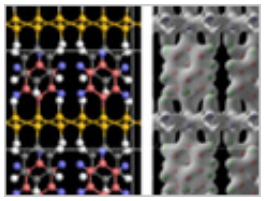
Grain boundaries in graphene grown by chemical vapor depositionLászló P Biró and Philippe Lambin2013 *New J. Phys.* **15** 035024



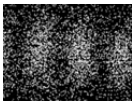
Chemical reactivity of aprotic electrolytes on a solid Li_2O_2 surface: screening solvents for Li–air batteriesTeodoro Laino and Alessandro Curioni2013 *New J. Phys.* **15** 095009



Dirac-cone-like surface state in W(110): dispersion, spin texture and photoemission from first principlesH Mirhosseini, M Flieger and J Henk2013 *New J. Phys.* **15** 033019



Interactions between stacked layers of phenyl-modified siliceneMichelle J S Spencer, Michael R Bassett, Tetsuya Morishita, Ian K Snook and Hideyuki Nakano2013 *New J. Phys.* **15** 125018



Quantum physics Show article list

One of the most interesting interplays in physics today is that between those studying foundations of quantum theory and those pushing the frontier of quantum technologies. This arises not only because of the broad interests of the researchers involved, but also because both areas require pushing the boundaries of our theoretical understanding of quantum theory and our experimental ability to create and controllably manipulate quantum coherence and entanglement. Many of the articles selected for this year's Highlights reflect this, the most dramatic example being the use of mathematical tools from quantum information to tackle a foundational question of the origin of the dimensionality of space (http://iopscience.iop.org/1367-2630/15/5/053040/) . We have selected articles reporting exciting progress in meeting the foundational experimental challenges in a diverse variety of systems: photonic qubits (http://iopscience.iop.org/1367-2630/15/5/053007/) , electron interferometry (http://iopscience.iop.org/1367-2630/15/3/033018/) and cavity opto-mechanics (http://iopscience.iop.org/1367-2630/15/3/035007/) . New theoretical challenges arise as we contemplate building ever larger clumps of controlled and coherent quantum matter, and two of our articles tackle interesting questions related to this limit, such as those about understanding and verifying the properties of such complicated systems (http://iopscience.iop.org/1367-2630/15/1/013043/) , and how can they be designed and exploited to hopefully maintain their quantum properties essentially indefinitely (http://iopscience.iop.org/1367-2630/15/5/055023/) .

Dr Terry Rudolph, Imperial College

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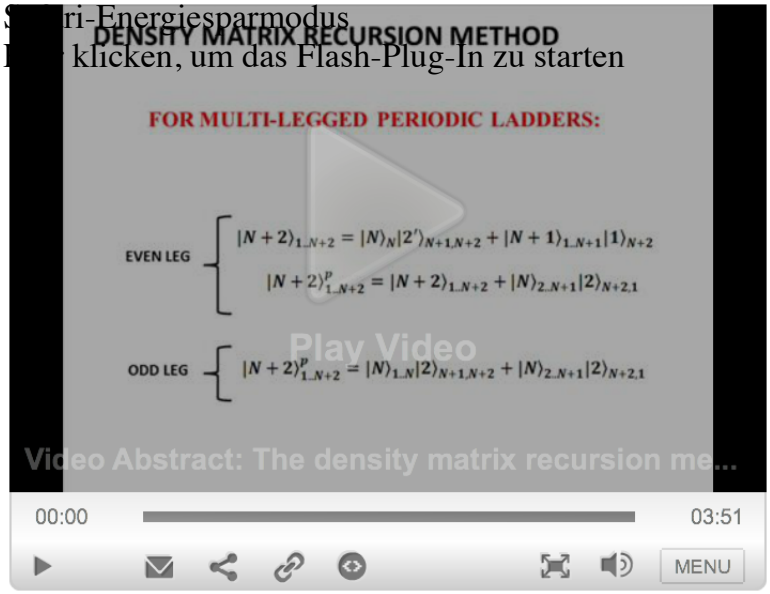
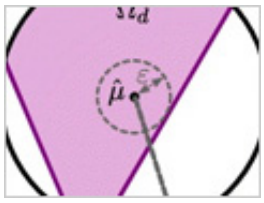
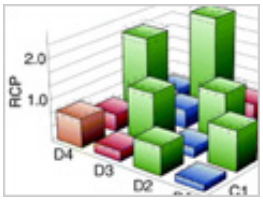


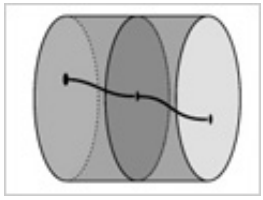
The density matrix recursion method: genuine multisite entanglement distinguishes odd from even quantum spin ladder statesHimadri Shekhar Dhar, Aditi Sen(De) and Ujjwal Sen2013 *New J. Phys.* **15** 013043



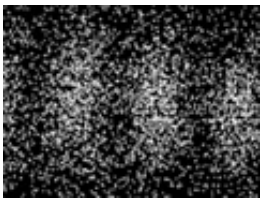
Three-dimensionality of space and the quantum bit: an information-theoretic approachMarkus P Müller and Lluís Masanes2013 *New J. Phys.* **15** 053040



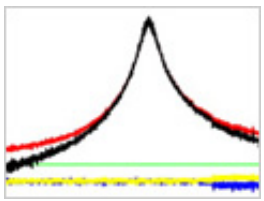
Photonic qubits, qutrits and ququads accurately prepared and delivered on demandPeter B R Nisbet-Jones, Jerome Dilley, Annemarie Holleczek, Oliver Barter and Axel Kuhn2013 *New J. Phys.* **15** 053007



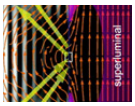
Self-correcting quantum computersH Bombin, R W Chhajlany, M Horodecki and M A Martin-Delgado2013 *New J. Phys.* **15** 055023



Controlled double-slit electron diffractionRoger Bach, Damian Pope, Sy-Hwang Liou and Herman Batelaan2013 *New J. Phys.* **15** 033018



Laser noise in cavity-optomechanical cooling and thermometryAmir H Safavi-Naeini, Jasper Chan, Jeff T Hill, Simon Gröblacher, Haixing Miao, Yanbei Chen, Markus Aspelmeyer and Oskar Painter2013 *New J. Phys.* **15** 035007



Quantum optics and lasers Show article list

Quantum optics has long been the technology of choice for experimental tests of the more unusual predictions of quantum mechanics. Quantum optics also plays a key role in emerging quantum technologies; not surprising given that optical communication is already a key component of many technologies. In 2013, both these aspects of quantum optics saw great progress.

New ideas to test quantum physics in gravitational fields have been discussed for more than two decades. In Quantum optics experiments using the International Space Station: a proposal (http://iopscience.iop.org/1367-2630/15/4/043008/article) Scheidl *et al* presented a thorough review of space-based quantum optics experiments that may come on line in the next two decades. Quite apart from testing quantum physics in a gravitational field, these experiments pave the way for new quantum communication and metrological schemes for space-based communication.

One of the most exciting quantum technology platforms to emerge in recent years is based on the control of macroscopic mechanical systems using light; the field of quantum opto-mechanics. These experiments indicate that the border between quantum and classical is not co-located with the traditional microscopic/macroscopic border. In Laser noise in cavity-optomechanical cooling and thermometry (http://iopscience.iop.org/1367-2630/15/3/035007/article) Safavi-Naeini *et al* review the experimental constraints on reaching highly non-classical regimes now that ground-state cooling of opto-mechanical systems has been achieved. Along the way they present a theoretical treatment of opto-mechanical cooling and thermometry.

The ability to engineer strongly interacting quantum system *de novo* has opened up a new path to quantum simulations and an ability to synthesize novel quantum states. A good example of what might be possible in quantum optics was presented by Hafezi *et al* in Non-equilibrium fractional quantum Hall state of light (http://iopscience.iop.org/1367-2630/15/6/063001/article) . They investigated the quantum dynamics of systems involving small numbers of strongly interacting photons. This provides a new path to quantum phase transitions beyond the conventional path through condensed matter physics.

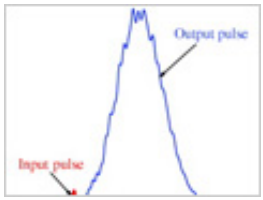
Like conventional technologies, emerging quantum technologies will need memories. Iakoupov and Sørensen in An efficient quantum memory based on two-level atoms (http://iopscience.iop.org/1367-2630/15/8/085012/article) propose a method, based on controlled reversible inhomogeneous broadening, to implement a quantum memory for light in ensembles of two-level atoms.

Quantum measurement and control will play a central role in quantum technologies. We now have a very good understanding of how to describe continuous weak measurements in quantum optics using the method of quantum trajectories. Horowitz and Parrondo *et al* in Entropy production along nonequilibrium quantum jump trajectories (http://iopscience.iop.org/1367-2630/15/8/085028/article) , generalize entropy production in

driven open classical systems to the quantum case. This work is an example of the growing interest in understanding how fluctuations in classical non-equilibrium steady states systems appear in a quantum setting.

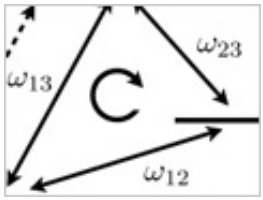
In Photon trajectories, anomalous velocities and weak measurements: a classical interpretation (http://iopscience.iop.org/1367-2630/15/7/073022/article) , Bliokh *et al* reconsider the experiment of Kocis *et al* [*Science* **332** 1170] that appeared to demonstrate the simultaneous determination of photon paths and optical interference. This was a variation on an old theme: how do we describe two-slit interference in terms of individual particle trajectories and Kocis showed that is was possible to interpret their results as a measurement of the Bhomian trajectories. Bliokh *et al* gave a classical optics interpretation of this experiment in terms of the Poynting-vector component of the electromagnetic interference field.

Gerard Milburn, University of Queensland

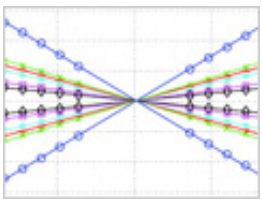


Transient lasing without inversionAnatoly A Svidzinsky, Luqi Yuan and Marlan O Scully2013 *New J. Phys.* **15** 053044

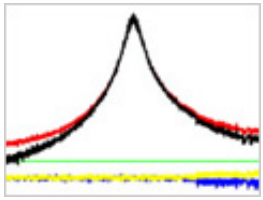
Quantum optics experiments using the International Space Station: a proposalT Scheidl, E Wille and R Ursin2013 *New J. Phys.* **15** 043008



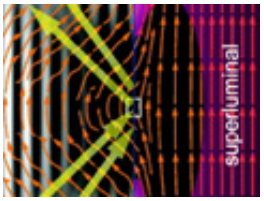
Entropy production along nonequilibrium quantum jump trajectoriesJordan M Horowitz and Juan M R Parrondo2013 *New J. Phys.* **15** 085028



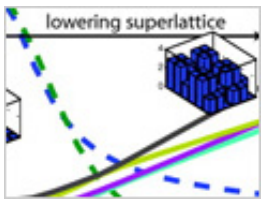
Shifts of optical frequency references based on spectral-hole burning in Eu^{3+}:Y_2SiO_5Michael J Thorpe, David R Leibrandt and Till Rosenband2013 *New J. Phys.* **15** 033006



Laser noise in cavity-optomechanical cooling and thermometryAmir H Safavi-Naeini, Jasper Chan, Jeff T Hill, Simon Gröblacher, Haixing Miao, Yanbei Chen, Markus Aspelmeyer and Oskar Painter2013 *New J. Phys.* **15** 035007

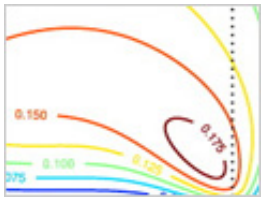


Photon trajectories, anomalous velocities and weak measurements: a classical interpretationKonstantin Y Bliokh, Aleksandr Y Bekshaev, Abraham G Kofman and Franco Nori2013 *New J. Phys.* **15** 073022

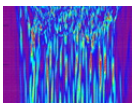


Non-equilibrium fractional quantum Hall state of lightMohammad Hafezi, Mikhail D Lukin and Jacob M Taylor2013 *New J. Phys.* **15** 063001

An efficient quantum memory based on two-level atomsIvan Iakoupov and Anders



S Sørensen2013 *New J. Phys.* **15** 085012

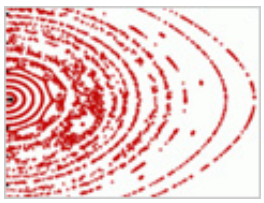


Plasma physics Show article list

2013 saw 32 papers in a focus issue on high-energy-density physics, some of them not even classed as plasma physics – so wide is the range of research in this subfield. There is naturally an emphasis on inertial fusion research given the prominence of the National Ignition Facility, with samples of the huge literature around NIF and ICF. For example, issues of fast ignition by tunnelling lasers, shocks and laser-accelerated protons; foams to reduce driver-imprinted surface variations and the resultant seed for Rayleigh-Taylor instabilities. However, there are many papers on indirectly related topics. For example, the growing interest in lasers for compact sources of multi-MeV protons for cancer therapy and other applications (protons with 100 s of MeV have been produced); very high harmonic light from laser plasma interactions (even at the surface of a blazed grating to automatically separate harmonics) to complement free-electron lasers; large changes in populations of different ionization states in plasmas not in LTE; modelling phase changes in solids (e.g. diamond to graphite) due to laser-excitation of electrons in the volume of a crystal. Looking beyond the Earth, opportunities are now emerging for laboratory-scale demonstrations of the astrophysical shocks thought to accelerate cosmic rays.

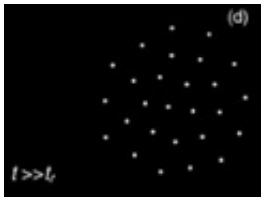
A hint of breadth of the rest of the field is given by the other 2013 articles selected here. The intriguing behaviour of dust in plasmas, where the inter-particle forces in a disturbed dusty plasma relaxing to equilibrium are shown to be very different from those in static dust distributions. In magnetic confinement fusion devices the complex relation between losses due to transport parallel to the sometimes partly stochastic magnetic field and the highly non-linear turbulent cross-field transport, and how detailed measurements can separate them. Laboratory generation and studies of highly collimated magnetically-driven jets seen in many parts of the universe.

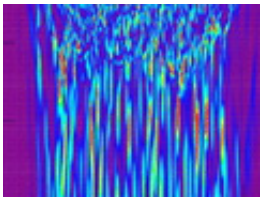
Dr William Morris, Culham Centre for Fusion Energy



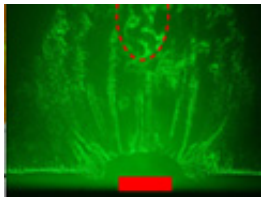
Topology bifurcation of a magnetic flux surface in magnetized plasmasK Ida, S Inagaki, Y Suzuki, S Sakakibara, T Kobayashi, K Itoh, H Tsuchiya, C Suzuki, M Yoshinuma, Y Narushima, M Yokoyama, A Shimizu, S-I Itoh and the LHD Experiment Group2013 *New J. Phys.* **15** 013061

Influence of external perturbations on the interaction between grains in plasmaE A Lisin, R A Timirkhanov, O S Vaulina, O F Petrov and V E Fortov2013 *New J. Phys.* **15** 053004

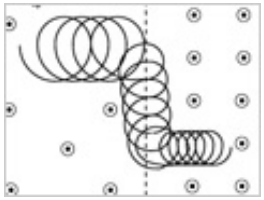




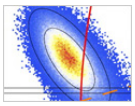
Simulations of laser imprint reduction using underdense foams and its consequences on the hydrodynamic instability growthM Olazabal-Loumé, Ph Nicolaï, G Riazuelo, M Grech, J Breil, S Fujioka, A Sunahara, N Borisenko and V T Tikhonchuk2013 *New J. Phys.* **15** 085033



Observation of energetic protons trapped in laboratory magnetic-tower jetsF Suzuki-Vidal, S Patankar, S V Lebedev, S N Bland, H Doyle, D Bigourd, G Burdiak, P de Grouchy, G N Hall, A J Harvey-Thompson, E Khoory, L Pickworth, J Skidmore, R A Smith and G F Swadling2013 *New J. Phys.* **15** 125008



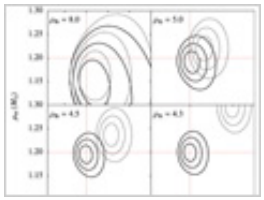
Diffusive shock acceleration at laser-driven shocks: studying cosmic-ray accelerators in the laboratoryB Reville, A R Bell and G Gregori2013 *New J. Phys.* **15** 015015



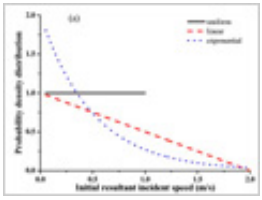
Astrophysics and cosmology Show article list

Visualization of the Gödel universeM Buser, E Kajari and W P Schleich2013 *New J. Phys.* **15** 013063

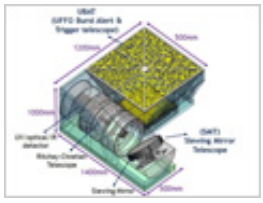
Does the CMB prefer a leptonic Universe?Dominik J Schwarz and Maik Stuke2013 *New J. Phys.* **15** 033021



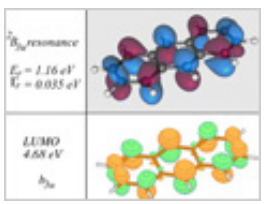
Avoiding selection bias in gravitational wave astronomyC Messenger and J Veitch2013 *New J. Phys.* **15** 053027



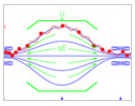
Incident velocity and incident angle of saltating sand grains on MarsXiao-Jing Zheng, Lin-Tao Fu and Tian-Li Bo2013 *New J. Phys.* **15** 043014



Ultra-Fast Flash Observatory for the observation of early photons from gamma-ray burstsI H Park, S Brandt, C Budtz-Jørgensen, A J Castro-Tirado, P Chen, P Connell, C Eyles, B Grossan, M-H A Huang, S Jeong, A Jung, J E Kim, S-W Kim, J Lee, H Lim, E V Linder, T-C Liu, K W Min, G W Na, J W Nam, M I Panasyuk, V Reglero, J Ripa, J M Rodrigo, G F Smoot, S Svertilov, N Vedenkin and I Yashin2013 *New J. Phys.* **15** 023031



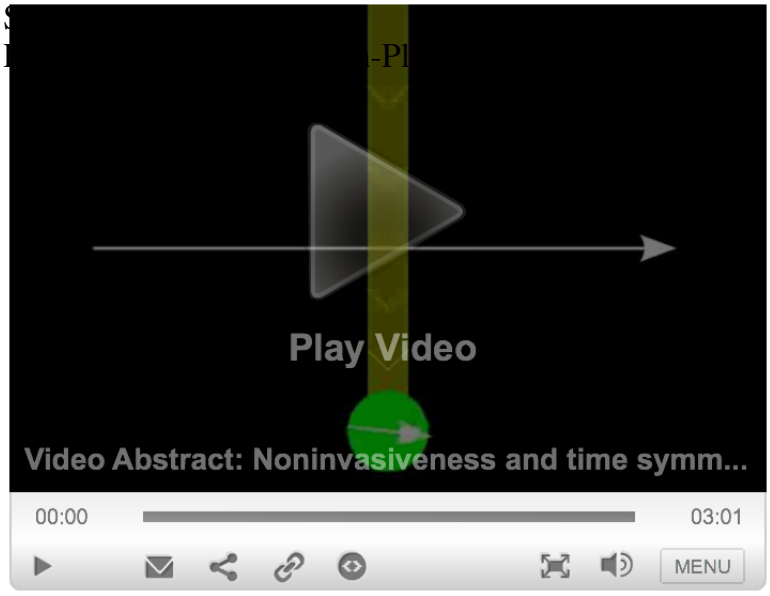
Dynamics of formation of anthracene anions in molecular clouds and protoplanetary atmospheresA Garcia-Sanz, F Carelli, F Sebastianelli, F A Gianturco and G Garcia2013 *New J. Phys.* **15** 013018



High energy particle physics Show article list

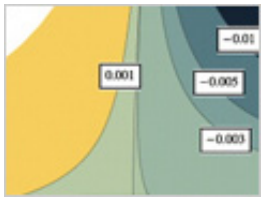
Physics at the shortest scales follows the laws of quantum mechanics, and are subject to the intrinsic invasiveness of microscopic measurements, namely the inevitability of system-detector interactions. Last year NJP published an interesting paper relating this issue to the possible failure of time symmetry and proposing a corresponding quantum-dot experiment. In broad terms, the field of particle physics seeks to determine the properties of the universe at large from the study of its elementary constituents at the high energies achievable at current accelerators. The underlying theory is the so-called standard model, which puts together quantum mechanics, Einstein's relativity with the principle of gauge symmetry, the three basic physics revolutions of the past century. In 2013, the discovery of the scalar boson responsible for the breaking of the electro-weak gauge symmetry was confirmed beyond reasonable doubt. Another highlight of the year came from the neutrino sector, and is associated to a more sensitive measurement of the third neutrino mixing parameter. This opens the tantalizing possibility of discovering the violation of time reversal symmetry in neutrino oscillations, the quantum mechanical process by which neutrinos exchange their identities as they propagate. Both discoveries are of paramount importance and related papers have also appeared at NJP. Finally, it could be that nature has more than the four dimensions that we have experienced so far and that are encoded in the formulation of the standard model. This was also reflected in NJP.

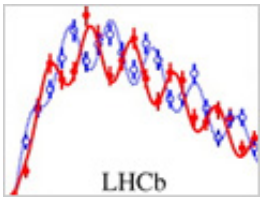
Professor Jose Valle, IFIC/CSIC and Universitat de València



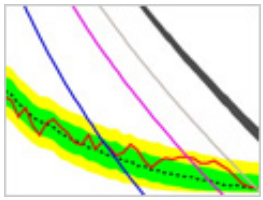
Noninvasiveness and time symmetry of weak measurementsAdam Bednorz, Kurt Franke and Wolfgang Belzig2013 *New J. Phys.* **15** 023043

Vacuum instabilities with a wrong-sign Higgs–gluon–gluon amplitudeMatthew Reece2013 *New J. Phys.* **15** 043003

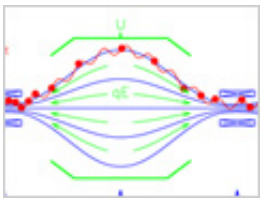




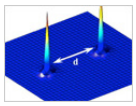
Precision measurement of the B^0_s–$\overline{B}^0_s$ oscillation frequency with the decay $B^0_s \to D^-_s\pi^+$The LHCb Collaboration2013 *New J. Phys.* **15** 053021



Search for extra dimensions in diphoton events from proton–proton collisions at $\sqrt{s} = 7$ TeV in the ATLAS detector at the LHCThe ATLAS Collaboration2013 *New J. Phys.* **15** 043007



Neutrino mass sensitivity by MAC-E-Filter based time-of-flight spectroscopy with the example of KATRINNicholas Steinbrink, Volker Hannen, Eric L Martin, R G Hamish Robertson, Michael Zacher and Christian Weinheimer2013 *New J. Phys.* **15** 113020



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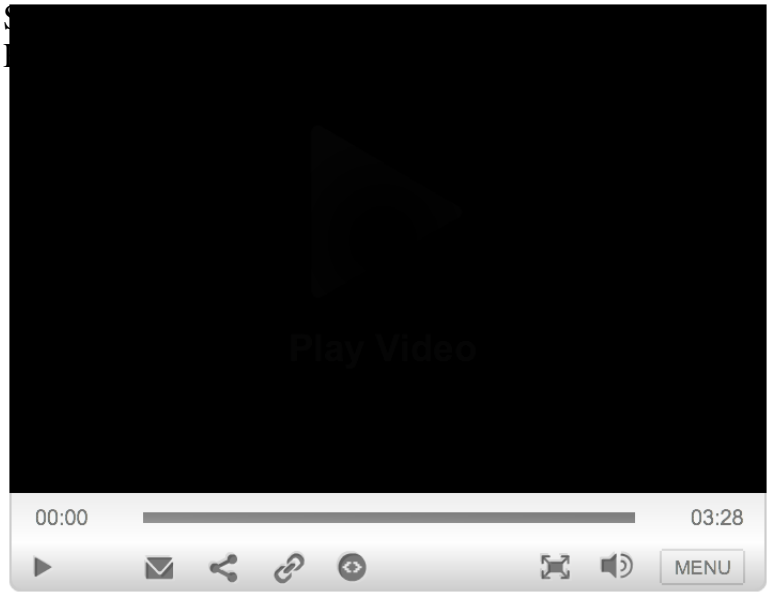
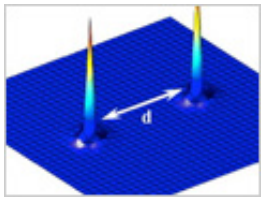
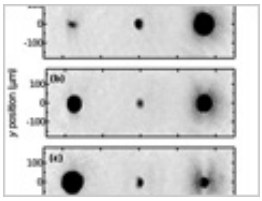


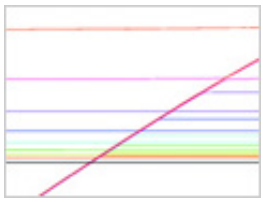
Rydberg state creation by tunnel ionizationA S Landsman, A N Pfeiffer, C Hofmann, M Smolarski, C Cirelli and U Keller2013 *New J. Phys.* **15** 013001

Topology by dissipationC-E Bardyn, M A Baranov, C V Kraus, E Rico, A İmamoğlu, P Zoller and S Diehl2013 *New J. Phys.* **15** 085001

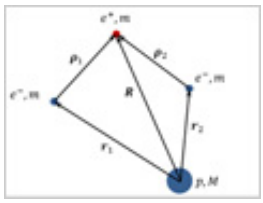




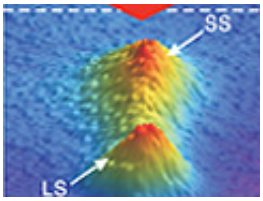
Direct observation of zitterbewegung in a Bose–Einstein condensateL J LeBlanc, M C Beeler, K Jiménez-García, A R Perry, S Sugawa, R A Williams and I B Spielman2013 *New J. Phys.* **15** 073011



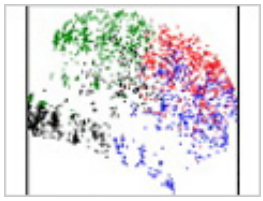
Resonant five-body recombination in an ultracold gas of bosonic atomsAlessandro Zenesini, Bo Huang, Martin Berninger, Stefan Besler, Hanns-Christoph Nägerl, Francesca Ferlaino, Rudolf Grimm, Chris H Greene and Javier von Stecher2013 *New J. Phys.* **15** 043040



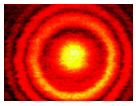
$\bar{H}^+$ ion production from collisions between antiprotons and excited positronium: cross sections calculations in the framework of the GBAR experimentP Comini and P-A Hervieux2013 *New J. Phys.* **15** 095022



Kinetic phase transition with global coupling in the resonantly driven atomic trapGeol Moon, Yonghee Kim, Myoung-Sun Heo, Daegun Ahn, Jina Park, Soyoung Shin, Heung-Ryoul Noh and Wonho Jhe2013 *New J. Phys.* **15** 103030



Machine learning of molecular electronic properties in chemical compound spaceGrégoire Montavon, Matthias Rupp, Vivekanand Gobre, Alvaro Vazquez-Mayagoitia, Katja Hansen, Alexandre Tkatchenko, Klaus-Robert Müller and O Anatole von Lilienfeld2013 *New J. Phys.* **15** 095003



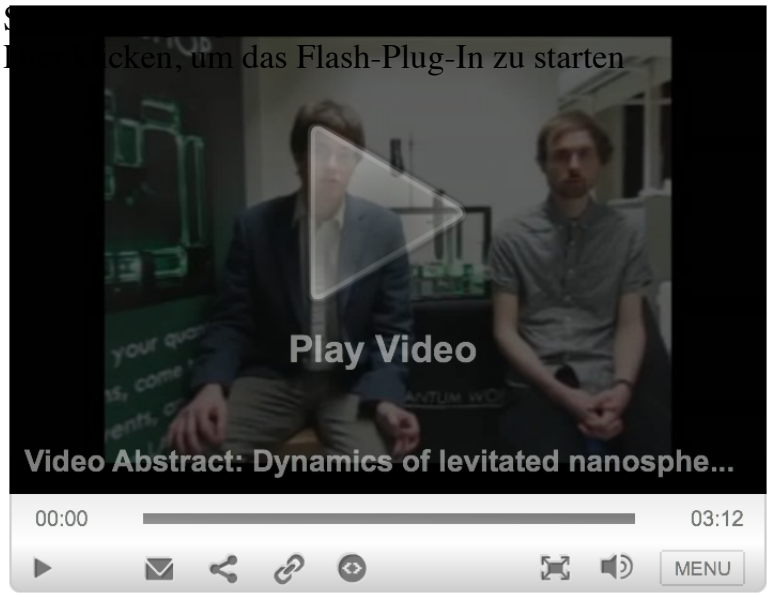
Nanophysics Show article list

Nanophysics is the multidisciplinary science of physical phenomena at the nanoscale. Inspiration for sub-areas such as nanophotonics, nanomechanics and nanoelectronics come from the convergence of fields as well as emerging applications of scientific breakthroughs. It is therefore a rich and exciting source of new physics.

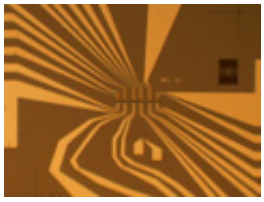
Leading-edge examples of nanophysics have been reported this past year in *New Journal of Physics*. Highlights related to nanomechanics include characterization of nanoscale heat transport by Otelaja *et al*., a novel detection of nanowire vibrations by Gil-Santos *et al*, and

the use of levitated nanospheres to cool a mechanical oscillator in order to realize quantum behavior, by Monteiro *et al*. In the area of nanophotonics Foreman and Vollmer reported that plasmonic nanoparticles can have a profound influence on whispering gallery modes in microresonators, thereby motivating development of a more powerful predictive theory. Mohtashami and Koenderink consider the applications of nitrogen-vacancy (NV) centres in nanodiamond as a single photon source. They emphasize the inhomogeity of emitted sites and report calibrated emission quantum efficiencies of NV centres. McGuinness *et al* also reported new work on NV centers in nanodiamonds. Their work demonstrates a striking detection of local spin environment with nanoscale resolution by tracking decoherence of single spin states in NV centers. The researchers envision that this work will inspire futuristic nanoscale probes that employ magnetic resonance imaging.

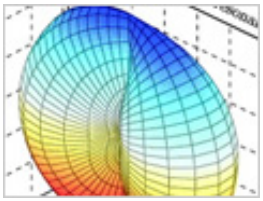
Professor Greg Scholes, Toronto University



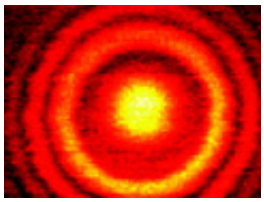
Dynamics of levitated nanospheres: towards the strong coupling regimeT S Monteiro, J Millen, G A T Pender, Florian Marquardt, D Chang and P F Barker2013 *New J. Phys.* **15** 015001



Design and operation of a microfabricated phonon spectrometer utilizing superconducting tunnel junctions as phonon transducersO O Otelaja, J B Hertzberg, M Aksit and R D Robinson2013 *New J. Phys.* **15** 043018

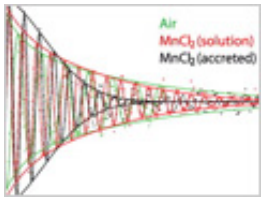


Theory of resonance shifts of whispering gallery modes by arbitrary plasmonic nanoparticlesMatthew R Foreman and Frank Vollmer2013 *New J. Phys.* **15** 083006

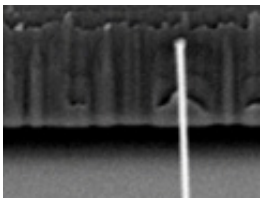


Suitability of nanodiamond nitrogen–vacancy centers for spontaneous emission control experimentsAbbas Mohtashami and A Femius Koenderink2013 *New J. Phys.* **15** 043017

Ambient nanoscale sensing with single spins using quantum decoherenceL P McGuinness, L T Hall, A Stacey, D A Simpson, C D Hill, J H Cole,



K Ganesan, B C Gibson, S Prawer, P Mulvaney, F Jelezko, J Wrachtrup, R E Scholten and L C L Hollenberg2013 *New J. Phys.* **15** 073042



Optical back-action in silicon nanowire resonators: bolometric versus radiation pressure effectsE Gil-Santos, D Ramos, V Pini, J Llorens, M Fernández-Regúlez, M Calleja, J Tamayo and A San Paulo2013 *New J. Phys.* **15** 035001

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