Highlights

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We are committed to promoting great science. Our most popular article in 2013 was read more than 7000 times.
Welcome

Dr Suzy Lidström
Editor-in-Chief

In line with the academy’s raison d’etre, “to promote the sciences and strengthen their influence in society”, I am determined to ensure that *Physica Scripta* is of genuine use to the scientific community. With this in mind, our invited papers, known as Invited Comments, have been extended in number and modified to suit a variety of readers. The popularity of these publications is demonstrating the appreciation of the readers. Our first undergraduate paper, applying maths to the physics of sport, notably cricket, was a global success, and our second, published in 2014, providing a truly ambitious explanation of the significance of the Higgs boson within a number of different fields, is well on its way to rivalling it. This year, teachers will be pleased to hear that the spreadsheet for the cricket paper will be made available and an invited paper considering different types of analysis of snails’ homing instincts will appear along with the data.

A fantastic series of review papers obtained from the Nobel Symposia on radioactive beams and on the physics of the LHC have made it possible to reproduce the success of the undergraduate papers for the research community. In connection with the latter, I have been engaged in a tremendous outreach programme. Where the Higgs boson was concerned, we had something for everyone, from children and adults with a vague interest in the subject to the most active researchers – I’ll be attending conferences all year to discuss this. The production of tailored reviews intended to enthuse young researchers about ongoing research is rapidly becoming one of our specialities and in 2014 we intend to publish our first extensive, comprehensive invited papers for postgraduates.

Submissions presenting novel research that has not been published elsewhere are welcome. *Physica Scripta* seeks to provide a valuable service and has no intention of engaging in an Impact Factor battle purely to gain “status” for the journal. We do not support the reduction of research to the lowest common element to increase publication lists. Like you, we are determined to play our part in improving standards in the scientific community.

From the Publisher

Yasmin McGlashan
Publisher, Physica Scripta

It was a pleasure for me to join the *Physica Scripta* team in 2013. Last year saw some big changes for the journal, including moving to a new editorial system, ScholarOne. We have published many high-quality articles, including some very popular Invited Comments and two Nobel Symposia on top of our regular journal articles. This brochure showcases just a small selection of the excellent work published in the journal. I hope you enjoy reading it. I would like to thank all of our authors, referees and members of the Editorial Board for their continued support and hard work for *Physica Scripta*. 
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Cover image: Predictions in the ($n_v$) plane of various monomodal models.
Adapted from figure 5 J Ellis 2013 Phys. Scr. T158 014020.
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Featured board member

Professor Margarita A Man’ko, one of the working editors of IOP Publishing, was appointed to the *Physica Scripta* Editorial Board in 2009. Her scientific activity at the P.N. Lebedev Physical Institute of the Russian Academy of Sciences is connected with quantum optics, signal analysis, optical communications and quantum technologies.

Professor Man’ko graduated from the Faculty of Physics of the M.V. Lomonosov Moscow State University and defended her PhD at the laboratory of the Nobel prize winner Professor N G Basov, at the P.N. Lebedev Physical Institute, where she now works as a leading senior researcher. The propagation of laser light through optical waveguides, quantum entropic and information properties of photon beams and the qudit system, and quantum tomography are among the topics of her research interests in recent decades.

Her work involves intense international collaboration with various European universities, in particular Lisbon and Naples, as well as with the University of Mexico. During the last decade, this collaboration has focused on such fundamental problems as obtaining new quantum entropic inequalities within the framework of the probability representation of quantum mechanics and quantum optics.

Since the 1980s, Professor Man’ko has participated in editorial activities at the Lebedev Institute, publishing the Proceedings of the Lebedev Institute in Russian with the famous publishing house “Nauka” (Science), also translated into English, and editing the *Journal of Soviet* (now Russian) Laser Research. Since the 1990s she has collaborated with IOP Publishing and in 2001 she became a co-ordinator of the IOPP Division at the Lebedev Institute. Her activities have been recognized through the award of a Certificate of Gratitude from IOP Publishing.

Professor Man’ko is also involved in the organization of several international conferences, in particular the annual Central European Workshop on Quantum Optics and the biannual International Conference on Squeezed States and Uncertainty Relations, as well as workshops on Nonstationary Quantum Systems, and the publication of Topical Issues and Comments sections from these conference proceedings.

Through this work with *Physica Scripta*, Professor Man’ko is encouraging the publication of high-level fundamental research on quantum physics and its applications, and helping the consolidation of the European and Russian scientific communities.
Topical Issues

Topical Issues contain selected papers resulting from prestigious symposia or conferences. Guest Editors choose those articles that best represent the content of their event and oversee a rigorous peer review process.

2013 saw the publication of seven separate Topical Issues, on topics ranging from nuclear physics to quantum optics. Physica Scripta was also fortunate to publish two Nobel Symposia within their Topical Issue programme last year: “Physics with Radioactive Beams” and “The Higgs Boson Discovery and Other Recent LHC Results”. These are the latest in a long line of Nobel Symposia published in Physica Scripta, a full list of which can be found online.

Looking towards 2014, Physica Scripta is hoping to develop its relationship with IOP Publishing’s Conference Series, working together to improve the options offered to those who wish to publish their high-quality work that has been presented at meetings or conferences. This relationship has already been forged in 2013 with the co-publication of the 2013 edition of “Functional Materials and Nanotechnologies”, which appeared in IOP Conference Series: Materials Science and Engineering, with a selection of the highest quality papers from the conference appearing within Physica Scripta in early 2014.

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Summary of the Nobel symposium on Large Hadron Collider results

John Ellis

2013 Phys. Scr. T158 014020

This is a personal summary of points made during, and arising from the symposium, drawing largely from the talks presented there. The standard model is doing fine, including QCD, the electroweak sector and flavour physics. The good news is that a standard model-like Higgs boson has appeared with the predicted mass. On the other hand, physics beyond the standard model is needed to explain neutrino masses and mixing. Cosmology and astrophysics also require new physics. Supersymmetry still seems to be the best-motivated extension of the standard model, and I look forward to the next phases of LHC operation at higher energy and luminosity.

The discovery and measurements of a Higgs boson

A L Read

2013 Phys. Scr. T158 014009

The discovery of a new fundamental particle with a mass of approximately 125 GeV by the ATLAS and CMS experiments at the Large Hadron Collider was announced at CERN on July 4, 2012. The subsequent measurements of the properties of the particle substantially strengthened the evidence that it is indeed the long-awaited Higgs boson predicted by the mechanism for which Francois Englert and Peter Higgs were awarded the Nobel Prize in Physics for 2013.
Neutrino experiments and the Large Hadron Collider: friends across 14 orders of magnitude

J M Conrad

2013 Phys. Scr. T158 014012

Despite the wide difference in energy scales, the LHC and neutrino experiments have a great deal of intellectual overlap. This review explores some of the questions that connect these experiments: What is the origin of mass? What is the meaning of flavor? Is there direct evidence of new forces or particles? To narrow the discussion, this review focuses on relatively new ideas for experiments that may be less known within the LHC community.

String theory: results, magic and doubts

Eliezer Rabinovici

2013 Phys. Scr. T158 014026

This talk was given at a special place and on a special occasion for a special audience. It describes the results, magic and doubts that an attempt to construct a theory based on the idea that the basic constituents of matter can also be extended objects has led to. The emphasis is on the spirit behind the ideas.

Future experimental programs

Hitoshi Murayama

2013 Phys. Scr. T158 014025

The discovery of the Higgs boson is a closure of particle physics in the 20th century, and, I believe, the dawn of new particle physics in the 21st Century. Yet it poses a very specific puzzle: where is the next energy scale in nature? I review five major puzzles that face us today, and discuss what we may learn from the detailed study of the discovered Higgs boson. Finally I briefly remark on high energy.
TOPICAL ISSUES

NOBEL SYMPOSIUM 152: PHYSICS WITH RADIOACTIVE BEAMS

Modern subatomic physics has experienced rapid technical developments recently, resulting in clean, intense energetic beams of exotic nuclei. As a consequence, this field is bursting with new ideas to study nuclei at the limits of stability. Experiments with energetic radioactive beams with half-lives down to the sub-millisecond region, reacting with various stable targets, allow studies of the structure of nuclei even at the extreme limits of stability. The world-leading experts made the Nobel Symposium a memorable event and the collection of review papers obtained from it provides a “Bible” for the younger generation for years to come.

Precision atomic physics techniques for nuclear physics with radioactive beams

Klaus Blaum et al

2013 Phys. Scr. T152 014017

Atomic physics techniques for the determination of ground-state properties of radioactive isotopes are very sensitive and provide accurate masses, binding energies, Q-values, charge radii, spins and electromagnetic moments. Many fields in nuclear physics benefit from these highly accurate numbers. They give insight into details of the nuclear structure for a better understanding of the underlying effective interactions, provide important input for studies of fundamental symmetries in physics, and help to understand the nucleosynthesis processes that are responsible for the observed chemical abundances in the Universe. Penning-trap and storage-ring mass spectrometry as well as laser spectroscopy of radioactive nuclei have now been used for a long time but significant progress has been achieved in these fields within the last decade. The basic principles of laser spectroscopic investigations, Penning-trap and storage-ring mass measurements of short-lived nuclei are summarized and selected physics results are discussed.

Facilities and methods for radioactive ion beam production

Y Blumenfeld et al

2013 Phys. Scr. T152 014023

Radioactive ion beam facilities are transforming nuclear science by making beams of exotic nuclei with various properties available for experiments. New infrastructures and development of existing installations enlarges the scientific scope continuously. An overview of the main production, separation and beam handling methods with focus on recent developments is done, as well as a survey of existing and forthcoming facilities world-wide.
Living on the edge of stability, the limits of the nuclear landscape

C Forssén et al

2013 Phys. Scr. T152 014022

A first-principles description of nuclear systems along the drip lines presents a substantial theoretical and computational challenge. In this paper, we discuss the nuclear theory roadmap, some of the key theoretical approaches, and present selected results with a focus on long isotopic chains. An important conclusion, which consistently emerges from these theoretical analyses, is that three-nucleon forces are crucial for both global nuclear properties and detailed nuclear structure, and that many-body correlations due to the coupling to the particle continuum are essential as one approaches particle drip lines. In the quest for a comprehensive nuclear theory, high performance computing plays a key role.

Tracking changes in shell structure in neutron-rich nuclei as a function of spin

Robert V F Janssens

2013 Phys. Scr. T152 014005

Taking advantage of the resolving power of modern gamma-ray spectrometers in combination with different types of nuclear reactions, it has been possible to investigate to fairly high-spin neutron-rich nuclei in a number of regions of the nuclear chart. The primary motivations for such studies are to characterize changes in shell structure as a function of the neutron-to-proton ratio and to document the impact of a large neutron excess on global properties, such as the nuclear shape. Recent data on nuclei close to the ‘island of inversion’ near 32Mg are discussed first. They highlight challenges in describing the observations with modern effective interactions. Subsequently, the nature of excitations in neutron-rich fp-shell nuclei between Ca and Ni is reviewed. A neutron sub-shell closure at N = 32 has been attributed to the monopole tensor force. Furthermore, the presence of collective excitations at moderate spin in neutron-rich Cr and Fe isotopes illustrates the role of the g9/2 orbital in driving the nuclear shape. The observations suggest that mixing between ‘deformed’ and ‘shell-model’ states needs to be considered. Finally, recent results in the direct vicinity of 68Ni indicate that the impact of the N = 40 neutron shell closure is rather modest.
Featured author

John Ellis currently holds the Clerk Maxwell Professorship of Theoretical Physics at King’s College in London. After obtaining a PhD from the University of Cambridge, and postdoctoral positions at SLAC and Caltech, he worked at CERN (Geneva) from 1973 to 2011, where he was Theory Division Leader for six years.

His research interests focus on the phenomenological aspects of elementary particle physics and its connections with astrophysics, cosmology and quantum gravity. Much of his work relates directly to experiment; interpreting results of searches for new particles and exploring the physics that could be done with future accelerators. A proposal he made in 1976 led to the discovery of the gluon in 1979, and he was one of the first to study how the Higgs boson could be produced and discovered. He has authored nearly 1000 scientific papers, with more than 50,000 citations in total. He is currently very active in efforts to understand the Higgs particle discovered recently at CERN, as well as its implications for possible new physics such as dark matter. For example, he and his collaborators have been comparing the properties of this particle with the predictions of the Standard Model – one of their papers was quoted by the Swedish Academy as saying that it is “beyond any reasonable doubt” a Higgs boson – and understanding the implications of the discovery for extensions of the Standard Model such as supersymmetry. He is also now studying possible future particle accelerators, such as the Compact Linear Collider (CLIC) and very large electron–positron and proton–proton circular colliders, and is known for his relentless efforts to promote global collaboration in particle physics.

John Ellis was awarded the Maxwell Medal (1982) and the Paul Dirac Prize (2005) by the Institute of Physics. He was elected Fellow of the Royal Society of London in 1985 and of the Institute of Physics in 1991, and is an Honorary Fellow of King’s College Cambridge and of the Serbian Physical Society. He has been awarded Honorary Doctorates by the University of Southampton, Uppsala University, the St Kliment Ohridski University, the Ukrainian Academy of Sciences and the University of Cape Town.

A paper written by John Ellis is included in Nobel Symposium 154 on p8
Enhancement of thermal quenching properties of a yellow-emitting SiO_2-coated Y_3Al_5O_{12}:Ce^{3+} phosphor for white light-emitting diode applications

Eun-Jun Chung et al.

2013 Phys. Scr. T157 014012

Ce^{3+}-activated Y_3Al_5O_{12} inorganic phosphor is an important component for lightning devices. In this paper authors have coated YAG:Ce^{3+} particles with silica to obtain material capable to generate warm-white light with excellent thermal quenching properties compared to conventional YAG:Ce^{3+} phosphor.

Tuning the electronic properties of naturally nanostructured compounds

E Feldbach et al.

2013 Phys. Scr. T157 014013

Compounds with nanopores and nanochannels (e.g. zeolites) enable easy tuning of their electronic properties by changing the ionic content of those nanospaces. In this paper authors demonstrated tuning of band gaps by changing the ionic content of nanopores (\textit{CaO}•\textit{Al}_2\textit{O}_9) and nanochannels (in Ca-phosphate apatite).

The lithium effect on the blue and red emissions of Er-doped zinc oxide thin films

S Bayoud et al.

2013 Phys. Scr. T157 014045

The Li–Er-codoped ZnO films show a higher intensity of blue and red emissions than the Er-monodoped ZnO films. The behavior of that enhancement is attributed to the modification of the local symmetry of the Er^{3+} ion, which increases the intra 4f transition of the Er^{3+} ion.
TOPICAL ISSUES
16TH INTERNATIONAL CONFERENCE ON THE PHYSICS OF HIGHLY CHARGED IONS

This Topical Issue contains the 105 proceedings papers of HCI 2012, held in Heidelberg, Germany, in September 2012. The physics of highly charged ions (HCI) is a rapidly developing and attractive field of research with impact on many other research disciplines. Apart from fundamental studies on the structure and dynamics of matter in extreme fields, or the search for physics beyond the standard model, detailed knowledge about the properties and behaviour of HCI is crucial for other areas, from astro- and solar physics to hot plasma and fusion research, and extreme ultraviolet and ion lithography, or even to medical research.

Soft x-ray emission from solar wind charge exchange in the laboratory

H Shimaya et al

2013 Phys. Scr. T156 014002

We have observed the emission spectra in collisions of bare oxygen ions with a helium gas target in the soft x-ray region with a window-less silicon drift detector at the collision energy range of 48–80 keV. The dominant soft x-ray emission corresponds to the 1s–2p transition of hydrogen-like oxygen O7+ produced by the single-electron charge exchange reaction. Other emission lines are the 1s–3p, 1s–4p and 1s–5p transitions of O7+, and also the 1s2–1s2p transition of O6+ produced by the true double-electron capture. The cascades from the upper states result in a large population of the 2p state, even though the direct capture into the 2p state is extremely scarcer than those into the 3p, 4p and 5p states.

Charge breeding rare isotopes for high precision mass measurements: challenges and opportunities

M C Simon et al

2013 Phys. Scr. T156 014098

Ion charge breeding for Penning-trap mass spectrometry has been established as providing a precision increase that scales linearly with the charge state of the ion. The mass spectrometer TRIUMFs ion trap for atomic and nuclear science is pioneering this field by coupling a Penning trap and an electron beam ion trap to the rare-isotope beam facility ISAC at TRIUMF. Here we present simulations that calculate and maximize the effective precision gain of time-of-flight ion-cyclotron-resonance measurements with highly charged ions of short-lived nuclides.
TOPICAL ISSUES

3RD INTERNATIONAL CONFERENCE ON TURBULENT MIXING AND BEYOND

A total of 63 papers were published in this Topical Issue, which is based on the event held in Trieste, Italy, in August 2011. The conference provided opportunities to bring together researchers from the areas, which include but are not limited to, fluid dynamics, plasmas, high-energy density physics, astrophysics, material science, combustion, atmospheric and earth sciences, nonlinear and statistical physics, applied mathematics, probability and statistics, data processing and computations, optics, and communications, and to have their attention focused on the long-standing formidable task of non-equilibrium turbulent processes.

The journey of hydrogen to quantized vortex cores

Gregory P Bewley and Jürgen Vollmer

2013 Phys. Scr. T155 014055

Nanoscale hydrogen particles in superfluid helium track the motions of quantized vortices. This provides a way to visualize turbulence in the superfluid. Here, we trace the evolution of the hydrogen from a gas to frozen particles migrating toward the cores of quantized vortices. Not only are the intervening processes interesting in their own right, but understanding them better leads to more revealing experiments.

What is mixing and can it be complex?

A Y Klimenko

2013 Phys. Scr. T155 014047

While the concept of mixing is commonly used in science and engineering, its exact interpretation may vary between different disciplines. In the present work, we analyse the concept of mixing in context of mechanical mixing, the ergodic theory, modelling of turbulent reacting fluid flows and complex competitive systems. Although mixing represents a dissipative process, which is responsible for irreversible increase of molecular disorder, mixing nevertheless can be associated with emergence of complexity under certain conditions. This dual role of mixing is noted and examined here. The appendix discusses three fundamental hypotheses, which are related to understanding of mixing and were introduced by Boltzmann.

Did you know?

Physica Scripta published a series of Comments also from this conference in Vol. 85 Issue 6 and Vol. 86 Issue 5, including one from author A Y Klimenko.
Predictive power and theoretical uncertainties of mathematical modelling for nuclear physics

**J Dudek et al**

*2013 Phys. Scr. T154 014002*

The article addresses the issue of prediction capacities as well as uncertainties of theoretical modelling, arguing that today’s theories often may provide not only the numbers treated as predictions comparable with the results of dedicated experiments but also additional information in the form of the estimates: Given limitations of the theoretical model, what is the probability with which theory’s predictions are expected to be verified by the experiments to come?

The full five-dimensional Bohr Hamiltonian from the generator coordinate method

**Stanisław G Rohoziński**

*2013 Phys. Scr. T154 014016*

The five-dimensional generator coordinate method with the five generator coordinates being the components of the quadrupole tensor is used to generate the nuclear collective quadrupole excitations by the vibrations and rotations of the intrinsic deformed ground state of the mean-field Hamiltonian.

On the Poincaré instability of a rotating liquid drop

**F A Ivanyuk and K Pomorski**

*2013 Phys. Scr. T154 014021*

The stability of a rotating nuclear liquid drop against pear-like deformations is studied within the optimal shape theory of Strutinsky using integro-differential equation techniques rather than numerical tabularization of the nuclear potential energy. It is found that such a break-up of reflection symmetric shapes appears in light nuclei at high angular momenta when non-axial degrees of freedom are taken into account.
The illusionist game and hidden correlations

G Brida et al

2013 Phys. Scr. T153 014006

We demonstrate a new protocol based on correlated beams of light: the ‘optical illusionist game’. An ‘illusionist’ at first shows that if two uncorrelated light beams excited in the same Gaussian state are mixed in a beam splitter, then no correlations arise between them. On the other hand, when correlations with an ancillary state are exploited, the presence of the beam splitter can be unveiled.

Single-photon-added coherent states: estimation of parameters and fidelity of the optical homodyne detection

S N Filippov et al

2013 Phys. Scr. T153 014025

The travelling modes of single-photon-added coherent states (SPACS) are characterized by using optical homodyne tomography. Given a set of experimentally measured quadrature distributions, we estimate parameters of the state and also extract information about the detector efficiency. The method used is minimal distance estimation between theoretical and experimental quantities, which additionally allows to evaluate the precision of the estimated parameters. The results are believed to encourage a more precise engineering and detection of SPACS.

This paper will influence the community of experimentalists making measurements of photon states by homodyne detection method to improve the analysis of the precision of their results.

Margarita Man’ko, Physica Scripta Editorial Board
Invited Comments

Comments articles can be commissioned to present new developments at the frontiers of research, to present inspirational material to undergraduate students, or in connection with workshops, meetings or the awarding of a prize. They are pedagogical presentations with the formulation adapted to three distinct groups of target readers:

- **Undergraduates.** These papers seek to illustrate particular issues or bring exciting new research to the attention of undergraduate students. They make excellent reading, having been written with the intention that they will be complementary to coursework.

- **Final-year undergraduates and research students.** Articles for these early researchers are written with the non-specialist reader in mind and therefore provide the background necessary to understand the topics being presented. They should be inspirational, broadening the horizon of the readers to provide an insight into a field, and assisting students to make professional choices about their career.

- **Postdocs.** Manuscripts in this category present extremely comprehensive and detailed information. They are ambitious in scope, provide thorough coverage of a research topic and are intended as a self-contained explanation of advanced topics relevant to new and ongoing research. The first examples of papers of this type will be published during 2014.

Publications of this kind are invited by the journal’s Editorial Board, sometimes in connection with meetings and workshops. They can be published in conjunction with the IOP Conference Series. Invited Comments must satisfy the pedagogical requirements appropriate for the intended readers because readability and clarity of the mathematical content are key to their success.

Forthcoming highlights include teaching papers for undergraduates on the Higgs boson, robotics, and snails’ homing instincts. Many Invited Comments will be featured for young researchers throughout the year, including one on climate forecasting, a series of crystallography papers modelled on the Nobel biographies and lectures written by Aminoff Prize winners, and others related to the Nobel prizes. In addition to these, our first postgraduate texts on nuclear symmetry and dynamics will be published towards the end of the year.
Is quantum theory intrinsically nonlinear?
From Comments on ‘Mathematical methods of studying physical phenomena’

Dieter Schuch

2013 Phys. Scr. 87 038117

In contrast with classical physics, complex quantities have a fundamental physical meaning in quantum physics and action, being essentially the quantized entity, should be given more attention instead of focusing mainly on Hamiltonians or Lagrangians that have the dimension of energy. Phase and amplitude of the complex quantities in (time-dependent and time-independent) quantum mechanics are not independent of each other but coupled via some conservation law. This coupling can be understood if the systems are described in terms of complex nonlinear Riccati equations. These equations not only enable a connection to the Pythagorean triples, probably the oldest and most abstract ‘quantization’ problem, but also lead to dynamical invariants with the dimension of action. Factorization of the corresponding operator provides generalized creation and annihilation operators, which is also possible for dissipative systems where no conventional Hamiltonian formalism exists. Formal similarities with other fields, particularly with nonlinear dynamics, are shown.

Initial state fluctuations and final state correlations: status and open questions

Andrew Adare et al

2013 Phys. Scr. 87 048001

The recent appreciation of the importance of event-by-event fluctuations in relativistic heavy-ion collisions has led to a large amount of diverse theoretical and experimental activity. In particular, there is significant interest in understanding the fluctuations in the initial stage of a collision, how exactly these fluctuations are propagated through the system evolution, and how they are manifested in correlations between measured particles. In order to address these questions a workshop was organized on ‘initial state fluctuations and final state correlations’, held at ECT* in Trento, Italy during the week of 2–6 July 2012. The goal was to collect recent work in order to provide a coherent picture of the current status of our understanding, to identify important questions that remain open, and to set a course for future research. Here we report the outcome of the presentations and discussions, focusing on the most important conclusions.
Challenging chemical concepts through charge density of molecules and crystals
From Comments on ‘Aminoff Prize in Crystallography’

Carlo Gatti
2013 Phys. Scr. 87 048102

Narrating my scientific career, I show in this paper how, starting as a computational and theoretical chemist, I got naturally involved with x-ray crystallographers because of the common interest in charge density and in the study of chemical bonds based on such an observable. The tools I devised and the conceptual developments I made to facilitate a profitable encounter between x-ray charge density and computational chemistry researchers are illustrated, with a special focus on the proposal and applications of the Source Function concept.

Partitioning and solubility of C60 fullerene in lipid membranes
From Comments on ‘Dynamics of biomolecular processes’

G Rossi et al
2013 Phys. Scr. 87 058503

Carbon nanoparticles (CNPs) are considered to be among the most promising nanomaterials, with applications in many different areas of technology. The interaction of CNPs with lipid membranes is of great interest because biological activity requires crossing or breaking lipid membranes. Moreover, lipid bilayers have been proposed to be efficient solubilizing agents for C60 and C70 fullerenes. In this comment, we review the literature on fullerene partitioning and dispersion in lipid membranes, considering both the experimental and the simulation literature, and highlighting similarities and differences.
Understanding electronic systems in semiconductor quantum dots

Orion Ciftja

2013 Phys. Scr. 88 058302

Semiconductor quantum dots are essentially small artificial atoms containing a finite adjustable number of electrons. In nature, the electrons in an atom are confined by the Coulomb attraction of the nucleus. However, in a semiconductor quantum dot they are confined by artificial experimental tools. Electrons are often trapped in a two-dimensional region of space via an electrostatic confining potential that has a “spring-like” form. The small size and confinement leads to enhanced quantum effects that profoundly affect the way in which electrons interact with each other, and with external parameters such as a magnetic field. The interplay between quantum confinement, electron–electron interaction effects and the magnetic field gives rise to very interesting physical phenomena. As a result, confined systems of electrons in a semiconductor quantum dot represent a unique opportunity to study the laws of quantum mechanics in a controllable atomic-like setup. This work draws attention to physical phenomena of technological importance that arise in confined two-dimensional electron systems in situations that are not available in real atoms.

Did you know?

Our submission process is entirely electronic, making it clear and simple for you to send us your paper

Did you know?

Papers published in 2013 received an average of 106 downloads each
Muon-spin-relaxation and inelastic neutron scattering investigations of the caged-type Kondo semimetals: CeT$_2$Al$_{10}$

(T = Fe, Ru and Os)

From Comments on ‘Frontiers of muon spectroscopy—25 years of muon science at ISIS’

D T Adroja et al

2013 Phys. Scr. 88 068505

Ce-based caged-type compounds with the general formula CeT$_2$Al$_{10}$ (T = Fe, Ru and Os) have generated considerable interest due to the Kondo semiconducting paramagnetic ground state observed in CeFe$_2$Al$_{10}$ and the anomalously high magnetic ordering temperature with spin gap formation at low temperatures in Kondo semimetals CeRu$_2$Al$_{10}$ and CeOs$_2$Al$_{10}$. The formation of long-range magnetic ordering out of the Kondo semiconducting/semimetallic state itself is extraordinary and these are the first examples of this enigmatic coexistence of electronic ground states.

These compounds also exhibit strong anisotropy in magnetic and transport properties and remarkable modification of magnetic and transport properties with doping. In this article, we discuss the bulk properties of these compounds, giving a detailed discussion of our muon-spin-relaxation (μSR) investigations and inelastic neutron scattering (INS) results. We present results for Ce(Ru$_{1-x}$Fe$_x$)$_2$Al$_{10}$ and CeOs$_2$Al$_{10}$ as well NdFe$_2$Al$_{10}$, NdOs$_2$Al$_{10}$ and YFe$_2$Al$_{10}$ for comparison.
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The research was featured in a number of outlets, including Fox News, The New York Times and The Telegraph.
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In 2013, several papers were published in connection with Nordic events and these will continue to grow in 2014, when several papers from open lectures and seminars at the Royal Swedish Academy of Sciences will appear in print.

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Half a century of fusion research towards ITER
Bo Lehnert

2013 Phys. Scr. 87 018201

A review is given on plasma physics and controlled thermonuclear fusion research since the late 1950s and up to the present day. Special emphasis is given to various proposed magnetic plasma confinement systems, as well as to the research aiming at the planned International Thermonuclear Experimental Reactor (ITER) project. The latter is based on the tokamak field geometry of a strong toroidal magnetic field, combined with an inductively imposed toroidal plasma current. Experimental and theoretical research has been conducted on the fundamental problems of confinement, equilibrium, stability, plasma transport and plasma heating. During this development two milestones have been passed on the way to ITER, namely the removed threat by Bohm diffusion at the end of the 1960s, and the discovery of the High Mode at the beginning of the 1980s. Finally, some future perspectives are shortly given on this line of research.

Cosmology and the dark matter frontier
Lars Bergström

2013 Phys. Scr. 87 014014

An overview is given on issues in current astroparticle physics, focusing on the dark matter (DM) problem, where the connection to LHC physics is particularly strong. New data from the Planck satellite has made the evidence in favour of the existence of DM even stronger. The favourite, though not the only, candidates for cosmological DM, weakly interacting massive particles, are being probed by a variety of experiments—direct detection through scattering in terrestrial detectors, indirect detection by observing products of annihilation of DM in the Galaxy and searches at accelerators such as the LHC. The field is in the interesting situation that all of these search methods are reaching sensitivities where signals of DM may plausibly soon be found, and a vast array of models will be probed in the coming years. Some of the puzzling and partly conflicting pieces of evidence for DM detection are discussed as well as expectations for the future.
Competing interaction in magnets: the root of ordered disorder or only frustration?

Per Nordblad

2013 Phys. Scr. 88 058301

What does the equilibrium atomic, molecular or spin configuration of a glass phase look like? Is there only one unique equilibrium configuration or are there infinitely many configurations of equal energy? The processes and mechanisms governing the path towards equilibrium, i.e. the dynamics of glassy systems, provide insights to these questions. Here we discuss the intrinsic dynamics of different glassy magnets: of spin-glasses, frustrated ferromagnets, superspin-glasses and other nanostructured systems with competing ferro- and antiferromagnetic interactions and randomness in their spatial distribution. This paper is intended as a brief update on some unsolved problems and the current empirical status in the field of disordered and frustrated magnetism.

Halos and related structures

K Riisager

2013 Phys. Scr. 87 014001

The halo structure originated from nuclear physics but is now encountered more widely. It appears in loosely bound, clustered systems where the spatial extension of the system is significantly larger than that of the binding potentials. A review is given on our current understanding of these structures, with an emphasis on how the structures evolve as more cluster components are added and on the experimental situation concerning halo states in light nuclei.
The twin paradox and the principle of relativity

Øyvind Grøn

2013 Phys. Scr. 87 035004

The twin paradox is intimately related to the principle of relativity. Two twins A and B meet, travel away from each other and meet again. From the point of view of A, B is the traveller. Thus, A predicts B to be younger than A herself, and vice versa. Both cannot be correct. The special relativistic solution is to say that if one of the twins, say A, was inertial during the separation, she will be the older one. Since the principle of relativity is not valid for accelerated motion according to the special theory of relativity B cannot consider herself as at rest permanently because she must accelerate in order to return to her sister. A general relativistic solution is to say that due to the principle of equivalence B can consider herself as at rest, but she must invoke the gravitational change of time in order to predict correctly the age of A during their separation. However one may argue that the fact that B is younger than A shows that B was accelerated, not A, and hence the principle of relativity is not valid for accelerated motion in the general theory of relativity either. I here argue that perfect inertial dragging may save the principle of relativity, and that this requires a new model of the Minkowski spacetime where the cosmic mass is represented by a massive shell with radius equal to its own Schwarzschild radius.

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This paper takes an elementary question as a starting point and shows how it connects to the deeper aspects of general relativity.

Gert Brodin, Physica Scripta Editorial Board
Physical mechanisms for electron mirror and field swelling modes

O A Pokhotelov et al

2013 Phys. Scr. 87 065303

Ion mirror instability is dominant in planetary and cometary magnetosheaths and other high-beta plasmas where the ions are hotter than the electrons. It is associated with a zero-frequency non-propagating mode with the wave vector nearly perpendicular to the ambient magnetic field. The counterparts of this instability in hot electron plasmas are the field swelling and electron mirror instabilities. A theory for these instabilities was developed more than two decades ago (Basu B and Coppi B 1982 Phys. Rev. Lett. 48 799, 1984 Phys. Fluids 27 1187) within the framework of a fluid model. The connection between the two types of instabilities has been analyzed in (Migliuolo S 1986 J. Geophys. Res. 91 7981). In contrast to these papers, we shall here adopt the standard quasi-hydrodynamic approach that is usually used for the study of mirror instabilities.
Simulation and modelling of charge transport in dye-sensitized solar cells based on carbon nano-tube electrodes

Yahia Gacemi et al

2013 Phys. Scr. 87 035703

Dye-sensitized solar cells (DSSC) are attracting attention owing to their low-cost, high flexibility and broad range of potential applications. They are promising candidates for the next-generation of solar cells. Using carbon nano-tubes as electrodes, these devices offer a viable alternative for improving solar cell efficiency. We clarify the charge transport in dye-sensitized solar cells with electrodes based on carbon nanotubes, and demonstrate how to improve the performance of such cells. The phenomena governing charge transport are recombination and generation. Modeling necessitates the numerical solution of the continuity equations using methods like the finite difference method. The current-voltage characteristics obtained reveal the effect on the performance of the electrodes for the cell studied. This conclusion is validated by comparing our results with experimental ones. The conversion efficiency was improved to 7.49 % for DSSC-based carbon nanotube electrodes. We offer a new perspective for researchers working in the field of DSSC.

Spectrum and energy levels of the Yb⁴⁺ free ion (Yb V)

Ali Meftah et al

2013 Phys. Scr. 88 045305

The spectrum of ionized ytterbium produced by a sliding spark source was recorded on the 10 m high resolution vacuum ultraviolet normal-incidence spectrograph of the Meudon Observatory. About 1080 lines attributed to Yb V, hitherto unknown, have been identified. The analysis of this spectrum established all the energy levels of the ground configuration 4f12 and, respectively 174, 12 and 43 levels of the excited configurations 4f115d, 4f116s and 4f116p. The theoretical calculations by means of the Cowan codes included a least-squares optimization of the relevant radial parameters by minimizing the differences between calculated and experimental level energies, which led to mean errors of 55 cm⁻¹ for the 56 even parity levels and 51 cm⁻¹ for the 186 odd parity ones. Interactions with the unknown core-excited configurations 5p54f13, 5p54f126p, 5p54f125d and 5p54f126s were taken into account.
Linear and nonlinear optical properties of anisotropic quantum dots in a magnetic field

Wenfang Xie

2013 Phys. Scr. 87 055704

We have investigated the linear and nonlinear optical properties of a two-dimensional anisotropic quantum dot in a magnetic field. Based on the computed energies and wave functions, the linear, third-order nonlinear and total optical absorption coefficients as well as the refractive index changes have been examined. The results are presented as a function of the incident photon energy for the different cases of anisotropy, dot size and external magnetic field. The results show that the linear and nonlinear optical properties of anisotropic quantum dots are strongly affected by the degree of anisotropy, the dot size, the external magnetic field and the polarized direction of the incident electromagnetic wave. The result also shows that the size effect of anisotropy quantum dots on the optical absorptions is different from that of isotropic quantum dots.

Dynamic Hubbard model: kinetic energy driven charge expulsion, charge inhomogeneity, hole superconductivity and Meissner effect

J E Hirsch

2013 Phys. Scr. 88 035704

Both the conventional Hubbard model and the dynamic Hubbard model are simplified descriptions of real materials, and whether or not they contain the physics of interest for particular real materials is in principle an open question. In this paper we have argued that the new physics that the dynamic Hubbard model incorporates beyond what is contained in the conventional Hubbard model is key to understanding many properties of high Tc cuprates as well as of superconductors in general. The new physics of the dynamic Hubbard model is that it allows the electronic orbital to expand when it is doubly occupied, as it occurs in real atoms. This expansion has associated with it outward motion of negative charge as well as lowering of the electron’s kinetic energy at the atomic level, and it is of course electron–hole asymmetric.
Electric and dielectric properties of nanostructured stoichiometric and excess-iron Ni–Zn ferrites

A Sutka et al

2013 Phys. Scr. 87 025601

In this paper, we report a study of the effect of excess iron on structural, microstructural, electric and dielectric properties of the nanostructured Ni–Zn ferrites Ni\(_{1-x}\)Zn\(_x\)Fe\(_{2+z}\)O\(_{4-δ}\) of different compositions with \(x = 0, 0.3, 0.5, 0.7, 1\) and \(z = 0, 0.1\). The structural and microstructural properties are estimated from x-ray diffraction and atomic force microscopy (AFM) data. The average grain size, evaluated from AFM topographical analysis, is found to be below 70 nm. The samples exhibit low values of dielectric constant and dielectric loss and a high resistivity. Contrary to earlier conclusions regarding microstructured Ni–Zn ferrites, in nanostructured Ni–Zn ferrites sintered at relatively low temperature and duration, the excess of iron in the composition increases the electrical resistivity and reduces the dielectric constant and loss tangent.

Electrical analysis of amorphous corn starch-based polymer electrolyte membranes doped with Lil

M F Shukur et al

2013 Phys. Scr. 88 025601

In this work, polymer electrolytes have been prepared by doping starch with lithium iodide (Lil). The incorporation of 30 wt% Lil optimizes the room temperature conductivity of the electrolyte at \((1.83 \pm 0.47) \times 10^{-4}\) S cm\(^{-1}\). Further conductivity enhancement to \((9.56 \pm 1.19) \times 10^{-4}\) S cm\(^{-1}\) is obtained with the addition of 30 wt% glycerol. X-ray diffraction analysis indicates that the conductivity enhancement is due to the increase in amorphous content. Dielectric studies show that all the electrolytes obey non-Debye behavior. The power law exponent \(s\) is obtained from the variation of dielectric loss, \(\varepsilon_i\), with frequency at different temperatures. The conduction mechanism of 70 wt% starch–30 wt% Lil electrolyte can be explained by the correlated barrier hopping model, while the conduction mechanism for 49 wt% starch–21 wt% Lil–30 wt% glycerol electrolyte can be represented by the quantum mechanical tunneling model.
**Broadband metamaterial absorber based on a multi-layer structure**

**Ding-e Wen et al**

*2013 Phys. Scr. 88 015402*

In this paper, a broadband metamaterial absorber (MA) based on a multi-layer structure is presented. The advantages of this MA are the small periodic unit size, thinness, excellent polarization characteristics and are adaptive for wide angles of oblique incident electromagnetic waves. The unit cell of the broadband MA is composed of three dual-band sub-cells; each presents two resonant frequencies so as to form a wide absorptive spectrum when stacked. The sandwiched dual-band sub-cell is composed of one metallic annular patch and one metallic circular patch each etched on a lossy substrate. The radii of the metallic patches forming each sub-cell are different so as to appear to have different resonant frequencies. The broadband MA presents good absorptivity above 80% between 8.8 and 10.8 GHz, with a full width at half maximum (FWHM) absorption bandwidth of 2.3 GHz and a relative FWHM absorption bandwidth of 23%.

**Approximate κ-state solutions of the Dirac equation in spatially dependent mass for the Eckart potential including the Yukawa tensor interaction**

**Sameer M Ikhdair**

*2013 Phys. Scr. 88 065007*

We investigate the analytical approximation to arbitrary κ-state solutions of the Dirac equation with the position-dependent mass particle in the Eckart potential including the Yukawa tensor interaction in the framework of a parametric Nikiforov–Uvarov method. By taking a proper approximation to deal with the centrifugal term, the analytical relativistic energy eigenvalues and the corresponding normalized two-spinor components of the wave function are obtained in closed form. The relativistic and non-relativistic bound state solutions for some special cases, such as the Hulthén potential and the generalized Morse potential, are easily obtained from our general solution.
Elemental investigation on Spanish dinosaur bones by X-ray fluorescence (XRF)

Antonio Brunetti et al

2013 Phys. Scr. 88 015802

In this paper we examine the chemical composition results obtained on a collection of 18 dinosaur fossil bones from Spain studied using a portable x-ray fluorescence spectrometer together with a reverse Monte Carlo numerical technique of data analysis. This approach is applied to the hypothesis of arbitrarily rough surfaces in order to account for the influence of the surface state of specimens on the chemical content evaluation. It is confirmed that the chemical content of elements is essential for understanding the changes brought about by diagenetic and taphonomic processes. However, for precise knowledge of what changes fossil bones have undergone after animal life and burial, it is necessary to use a multi-technique approach making use of other instruments like x-ray diffraction in order to describe accurately the transformations undergone by the mineralogical and bioinorganic phases and the properties of specific molecular groups.

Gradual growth of gold nanoseeds on silica for SiO$_2$@gold homogeneous nano core/shell applications by the chemical reduction method

H Rezvani Nikabadi et al

2013 Phys. Scr. 87 025802

In this paper, a facile method for the synthesis of gold nanoseeds on the functionalized surface of silica nanoparticles has been investigated. Mono-dispersed silica particles and gold nanoparticles were prepared by the chemical reduction method. The thickness of the Au shell was well controlled by repeating the reduction time of HAuCl$_4$ on silica/3-aminopropyltriethoxysilane (APTES)/initial gold nanoparticles. The prepared SiO$_2$@gold core/shell nanoparticles were studied using x-ray diffraction, scanning electron microscopy, transmission electron microscopy (TEM), Fourier transform infrared spectroscopy and ultraviolet visible (UV–Vis) spectroscopy. The TEM images indicated that the silica nanoparticles were spherical in shape with 100 nm diameters and functionalizing silica nanoparticles with a layer of bi-functional APTES molecules and tetrakis hydroxy methyl phosphonium chloride. The gold nanoparticles show a narrow size of up to 5 nm and by growing gold nanoseeds over the silica cores a red shift in the maximum absorbance of UV–Vis spectroscopy from 524 to 637 nm was observed.
Lower hybrid drift instability in a current sheet with anisotropic temperature

**Feng Huang et al**

2013 *Phys. Scr.* **87** 065501

The effect of the temperature anisotropy on the lower hybrid drift instability (LHDI) in a current sheet is investigated using local kinetic theory. It is found that the ratio of the perpendicular to parallel electron temperatures can significantly affect the instability. In fact, a critical value exists, such that when the LHD waves are unstable if the perpendicular wave vector is between two threshold values, and when the LHD mode is stable for any. It is also found that increases and the unstable LHD regime shrinks as the parallel wave vector increases. That is, sufficiently low perpendicular electron temperature can stabilize the LHDI, especially that of short parallel wavelength.

*The authors here present a new mechanism for the stabilization of the lower hybrid drift instabilities. This is of much interest to plasma physicists and space physicists.*

**Lennart Stenflo, Physica Scripta Editorial Board**

Some unexplored features of the nonlinear compressive magnetoacoustic Alfvénic waves

**J Vranjes and B P Pandey**

2013 *Phys. Scr.* **88** 035504

The theory of nonlinear magnetoacoustic wave in the past has strictly been focused on purely compressive features of the mode. We show that a complete set of nonlinear equations necessarily includes both compressional and shear components of the magnetic field. These two turn out to be described by exactly the same nonlinear equations, which make the use of such a complete full set of equations far less complicated than expected. Present results should considerably enrich the theory of these waves by opening up new frontiers of investigation and providing some completely new types of nonlinear solutions.
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