PROGRAM AND ABSTRACT BOOKLET

MAP-FIS PhD RESEARCH CONFERENCE 2008/2009

Science School Auditorium, University of Minho, Portugal, 16-17 January 2009

The Conference

MAP-fis is the joint doctoral programme in Physics of Universidade do Minho, Universidade de Aveiro and Universidade do Porto (MAP).

One of the main objectives of the recently implemented MAP-Fis program is to create new links and strengthen existing collaborations between researchers at the "MAP" Universities (Minho, Aveiro and Porto), the associated National Laboratories and Research Centers. One important step towards increasing the scientific interactions between investigators at these organizations is the presentation of current PhD research results during an informal conference. The very first MAP-Fis PhD research conference will be held in at the Universidade do Minho in Braga, on Friday and Saturday, January 16-17, 2009.

The conference will have four sessions grouped within the following general research topics:

- **Thin films and nanostructures**
- **Theory**
- **Photonics, sensors, and color**
- **Current topics in magnetism**

There will be a poster session also organized in terms of the above general topics.

MAP-Fis Scientific Committee

D. S. Schmool, Program Director (University of Porto)

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PROGRAM

Talks are 15 min. long plus 5 min. for discussion.

Friday, January 16

09:45 - 09:55 Welcome by MAP-fis and organizers

Thin films and nanostructures

09:55 – 10:15 **A. G. Macedo**
"Functionalisation of scanning microscope tips (AFM and SNOM) by dielectrophoretic assembly of Gd_2O_3:Eu^{3+} nanorods and nanotubes"

10:15 – 10:35 **S. S. Nobre**
"Amorphous and lamellar Eu(III)-based bridged silsesquioxanes"

10:35 – 10:55 **E. Malainho**
"Modelling of the dielectric function of amorphous silicon with application to thin films for solar cells"

10:55 - 11:15 Coffee break

11:15 – 11:35 **C. Batista**
"Thermochromic thin films based on vanadium dioxide for energy efficient windows"

11:35 – 11:55 **P. Cardoso**
"Electrical properties of carbon nanofibre polymer composites"

11:55 – 12:15 **C.T. Sousa**
"Ordered assembly of oxide nanotubes in a porous alumina membrane"

12:15 – 12:35 **V. Sencadas**
"Investigation of the α to β phase transformation of poly(vinilidene fluoride) and its relationship with the macroscopic electro-mechanical response of the material"

12:35 - 14:00 Lunch break

Theory

14:00 - 14:20 **A. Ferreira**
"Quantum correlations mediated by spin chains"

14:20 - 14:40 **M. J. Sampaio**
"Global SO(3) $\times$ SO(3) $\times$ U(1) symmetry of the Hubbard model on the square lattice and its physical consequences"

14:40 – 15:00 **T. V. Martins**
"Divide and conquer"

15:00 – 15:20 **L. F. P. O. Costa**
"A gravito-electromagnetic analogy based on tidal tensors"

15:20 – 15:40 **C. Rebelo**
"Two limits of the double Kerr solution

15:40 – 16:50 Poster Session

Photonics, sensors, and color

16:50 - 17:10 **L. Fernandes**
"Fibre Bragg gratings in suspended core fibres"

17:10 - 17:30 **D. A. Pereira**
"Spectral and spatial mode control in self-seeded semiconductor disk laser using optical feedback from fiber Bragg grating"

17:30 - 17:50 **C. D. R. Azevedo**
"Gas VUV photosensors operating face-to-face at HpXe"

17:50 - 18:10 **C. A. B. Oliveira**
"Development of simulation platforms for MPGDs"

18:10 - 18:30 **J. P. Carvalho**
"Gas detection system based on wavelength modulation spectroscopy and hollow-core photonic crystal fibres sensing heads"

18:30 - 18:40 Short break

18:40- 19:00 **C. Maule**
"Ratiometric sensing and imaging with CdTe semiconductor nanocrystals for biomedical applications"

19:00 - 19:20 **J. Viegas**
"Slotted multimode interference device for chemical and biochemical sensing"

19:20 - 19:40 **J. M. M. Linhares**
"The number of colours and their distribution for normal and colour deficient observers in natural scenes"

Saturday, January 17

Current topics in magnetism

10:00 - 10:20 **J. S. Amaral**
"Advances in magnetic and magnetocaloric studies"

10:20 - 10:40 **I. T. Gomes**
"Structural and magnetic characterization of $LaSrMnO_3$ thin films deposited by laser ablation"

10:40 - 11:00 **J. G. Barbosa**
"Contributions to the magnetic anisotropy in $BaTiO_3$-$CoFe_2O_4$ nanogranular composite films"

11:00 – 11:20 **A. M. Pereira**
"Magnetic and structural phase diagram of $HO_5(Si_xGe_{1-x})_4$ system"

11:20 - 11:40 Coffee break

11:40 - 12:00 **W. S. Ferreira**
"Raman scattering study in $Eu_{1-x}Y_xMnO_3$ ceramics"

12:00- 12:20 **J. M. Teixeira**
"Temperature dependent transport properties of MgO-based ultra-thin magnetic tunnel junctions: experiment and modelling"

12:20 - 12:40 **L. M. C. Pereira**
"Ferromagnetism vs. local structure in transition metal doped wide-gap semiconductors"

12:40 - 13:00 Concluding remarks

POSTERS

Poster Session – 17/01/2009

E. S. Marins
"Thin-film silicon solar cells deposited on flexible substrates"

F. Figueiras
"Thin film deposition of Ni-Mn-Ga alloy onto Si and PZT buffer substrates by RF magnetron sputtering at room temperature"

A. Khodorov
"Graded PZT Films Produced by Pulsed Laser Deposition"

S. R. C. Pinto
"Ge nanocrystals for flash memories: a quantitative study of size distribution"

J. N. Gonçalves
"Ab-initio calculations on manganites: hyperfine quantities for interpretation of perturbed angular correlation experiments, and other properties"

D. Viegas
"A new interrogation scheme for surface plasmon resonance sensors based on fibre Bragg gratings"

C. M. S. Vicente
"Optical Waveguides and Bragg Gratings patterned on Sol-Gel derived Zirconium modified Di-ureasils using Laser Direct Writing"

A. Ghasempour
"Hybrid sol-gel integrated optic beam combiners for astronomical interferometry"

P. Caldas
"Effect of fiber tapering in modal LPG-based Mach-Zehnder interferometers for refractive-index sensing"

D. Alexandre
"Laser direct writing unit for rapid prototyping of integrated optical micro devices"

B. Neto
"Optimization metaheuristics based upon the genetic algorithm for hard problems in telecommunications"

D. C. Leitão
"Delocalized versus localized magnetization reversal in template-grown Ni and Ni80Fe20 nanowires"

C. A. F. Marques
"Global atmospheric energetics in the wave number domain"

Friday, January 16

FUNCTIONALISATION OF SCANNING MICROSCOPE TIPS (AFM AND SNOM) BY DIELECTROPHORETIC ASSEMBLY OF GD_2O_3:EU^{3+} NANORODS AND NANOTUBES

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2 Universidade de Aveiro, Departamento de Química, Aveiro, Portugal, 3810

An atomic force microscopy (AFM) tip has been coated with photoluminescent Eu^{3+}-doped Gd_2O_3nanorods using a dielectrophoresis technique, which preserves the red emission of the nanorods (quantum yield 0.47).[1] The performance of the modified tips has been tested by using it for regular topography imaging in tapping and contact modes. Both a regular AFM standard grid and a patterned surface (of an organic-inorganic methacrylate Zr-based oxo-cluster and poly(oxyethylene)/siloxane hybrid) have been used. Similar depth values have been measured using a conventional silicon tip and the nanorods-modified tip. The tips before and after use exhibit similar SEM images and photoluminescence spectra and, thus, seem to be stable under working conditions. The application of these tips in scanning near-field optical microscopy (SNOM) [2] is presently under way.

9h55
Fri
1

1. A. G. Macedo, D. Ananias, P. S. André, R. A. S. Ferreira, A. L. Kholkin, L.D. Carlos, J. Rocha, Nanotech 19 295702 (2008)
2. Collaboration with L. Aigouy, P. Lalanne, J. P. Hugonin, G. Julie, V. Mathet, M. Mortier. Phys Rev Lett 98 153902 (2007)

AMORPHOUS AND LAMELLAR EU(III)-BASED BRIDGED SILSESQUIOXANES

Sónia S. Nobre [1,2], Rute A. S. Ferreira [1], Xavier Cattöen [2], Carole Carcel [2], Michel Wong Chi Man [2] , Joël J.E. Moreau [2], Luís D. Carlos [1]

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[2] Ecole Nationale Supérieure de Chimie de Montpellier, Laboratoire Architectures Moléculaires et Matériaux Nanostructurés (UMR-CNRS 5253) - 8, rue de l'école normale, 34296 Montpellier CEDEX 05, France

10h15
Fri
2

Organo-bridged silsesquioxanes are hybrid materials with potential technological applications owing to the myriad of properties that can be introduced through the organic fragments. The introduction of urea as self-associative groups in the organic fragment and also under the acid-catalysed hydrolytic condensation allowed a good control of the organisation of these solids at various scale lengths [1,2]. Here we report the photoluminescence features of Eu^{3+}-based organic-inorganic hybrids capable of self-assembly, changes on the synthesis procedure induce the formation of amorphous or lamellar hybrids. A recent work reports preliminary results on the effects of the self-assembling of the nanobuild blocks (in this case of an aromatic ring) on the photoluminescence properties of the hybrids without Eu^{3+} [3]. The emission in these materials arises from a mixture of components related with the aromatic rings and the urea bridges [3]. Here we will study the lamellar [4] and the amorphous hybrids without and incorporating $EuCl_3.6H_2O$ in order to understand the effects of the self-assembling of the nanobuild block on the structural and photoluminescence features. The hybrid-to-Eu^{3+} energy transfer will be also addressed.

[1] J.J.E. Moreau, L. Vellutini, M. Wong Chi Man, C. Bied, J.-L. Bantignies, P. Dieudonné, and J.-L. Sauvajol, *JACS*, **2001**,123, 7957-7958.
[2] J.J.E. Moreau, B.P. Pichon, M. Wong Chi Man, C. Bied, H. Pritzkow, J-L. Bantignies, P. Dieudonné, J-L. Sauvajol, *Angew. Chem. Int. Ed.*, **2004** 43, 203-206.
[3] L.D. Carlos, R.A. Sá Ferreira, S.S. Nobre, M. Wong Chi Man, J.J.E. Moreau, C. Bied, B.P. Pichon, *Mater. Sci. Forum (Advanced Materials Forum III)*, **2006**,514-516, 118-122.
[4] S. S. Nobre, C. D. S. Brites, R. A. S. Ferreira, V. D. Bermudez, C. Carcel, J. J. E. Moreau, J. Rocha, M. W. C. Man and L. D. Carlos, *J. Mater Chem*, **2008**, 18, 4172-4182.

MODELLING OF THE DIELECTRIC FUNCTION OF AMORPHOUS SILICON WITH APPLICATION TO THIN FILMS FOR SOLAR CELLS

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2 CENIMAT/I3N - CEMOP, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal

The accurate determination of the optical gap (E_g) of hydrogenated amorphous silicon (a-Si:H) is important for modern solar cell technology. While for thick a-Si:H films, E_g is usually estimated from so called Tauc plot, this is not possible for thin films because of the interference effects. In order to take them properly into account, it is necessary to have an appropriate expression for the complex dielectric function of a-Si, valid below and above the optical gap. The goal of this work has been to derive such an expression that would be physically founded, (semi-)analytical, and using a small number of adjustable meaningful parameters, including E_g and the characteristic energy scale of the absorption tail in the sub-gap region. We considered two different models of disorder designated as model A and model B (see Fig. 1), both related to the band edges' fluctuations and leading to the sub-gap absorption and Urbach-type tails. According to the model A, we considered the fluctuations of the joint density of states of the conduction and valence bands with respect to the average value for each band. The model B is concerned with the fluctuations of the optical transition matrix element, related to the local electric fields (i.e., to the band energies slope in real space) that facilitate the photon-assisted tunnelling between the bands. Both models lead to similar functional dependences of the imaginary part of the dielectric function on the photon energy. With this description of the complex dielectric function and using the transfer matrix formalism for multilayer optics, we performed the modelling of the optical spectra of several a-Si:H thin films produced for photovoltaic cell applications. We achieved a good agreement between the calculated and experimental transmittance spectra, which allowed us to self-consistently determine the values of the above parameters. We found that E_g and the characteristic scale of the sub-gap absorption tail, both increase with the hydrogen addition. We have also determined the absorption rate spectra of the films, relevant to the photothermal deflection spectroscopy of sub-gap states.

10h35
Fri
3

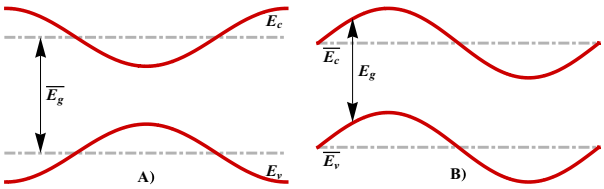

Fig. 1: Disorder models: A) fluctuation of the gap energy while P_{cv} is maintained approximately constant; B) the gap energy keeps constant while P_{cv} fluctuates.

THERMOCHROMIC THIN FILMS BASED ON VANADIUM DIOXIDE FOR ENERGY EFFICIENT WINDOWS

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11h15
Fri
4

The latest approach on the improvement the energy efficiency of buildings is based on the use of thermochromic coatings on so-called "smart" windows. These coatings possess the ability of changing their optical properties as a consequence of a reversible structural transformation when going through a critical temperature. Vanadium dioxide is an example of a transparent thermochromic material which is a promising candidate for this kind of application. The change on its optical and also electrical properties takes place at 68^{o}C as a result of a first-order structural transition, known as Mott transition [1], going from a monoclinic to a tetragonal phase on heating. The low temperature semiconducting phase which is transparent to radiation in the visible and infrared wavelength range maximizes the heating due to blackbody radiation, while the metallic high temperature phase blocks the infrared radiation and maintains at the same time the transparency required, in the visible range, to keep an environment of natural light. A transition temperature of 68^{o}C is too high for this application and must therefore be reduced. Tungsten-doping of VO_2 has demonstrated to decrease the transition temperature in the greatest extent, when compared with other metals, and has therefore been the focus of most of the research [2].
In the current study, pure VO_2 thin films and also doped with different W at.% and consequent dissimilar switching temperatures, were successfully deposited onto SiO_2-coated float-glass substrates by reactive direct current (DC) magnetron sputtering. The films have been characterized in terms of crystal structure and texture by x-ray diffraction (XRD) and the morphology of the surface has been analyzed and quantified by scanning electron microscopy (SEM) and atomic force microscopy (AFM). The optical/thermochromic behavior of the different films has been studied by optical spectrophotometry in the UV-VIS-NIR range.

[1] A. Zylbersztejn and N.F. Mott, Physical Review B 11 (1975) 4383-4395.
[2] I.P. Parkin and T.D. Manning, Journal of Chemical Education 83 (2006) 393-400.

ELECTRICAL PROPERTIES OF CARBON NANOFIBRE POLYMER COMPOSITES

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The excellent mechanical and transport properties of carbon nanofibres, in combination with their economy, make them perfectly fit for use in polymer composites. Recent research shows an increased level of insight into nanofibre composite properties and processing at high rates and low costs, by quantifying processing-morphology-properties relationships. It specifically shows the promise of using the electrical properties of these materials, both in process monitoring and potential applications [1-4].
A study of the electrical and rheological properties of epoxy resin with carbon nanofibres before and after the curing process has been performed. The amount and dispersion of the carbon nanofibres in the resin has deep influence on the macroscopic electrical and mechanical properties of the composites. The suitability of these composites for piezoresistive sensors applications will be discussed.

11h35
Fri
5

1. F.W.J. van Hattum, and M.L. Lake, "Exploring the use of Carbon Nanofibre Reinforced Polymer Composites", *Commercialising Conductive Polymers 2003*, Barcelona, Spain, 2003
2. S.Y. Yang, R. Benitez, A. Fuentes, and K. Lozano, "Dielectric analysis of VGCNF reinforced polyethylene composites", *Comp. Sci. Techn.* 67, p.1159 (2007)
3. D. G. Glasgow, R.L. Jacobsen, D.J. Burton, C. Kwag, E. Kennel, M. L. Lake, W.J. Brittain, and B.P. Rice, "Carbon Nanofiber Polymer Composites", *Proc. SAMPE'03*, 11-15 May, Long Beach, CA, USA (2003)
4. E. Hammel , X. Tang , M. Trampert , T. Schmitt , K. Mauthner , A. Eder and P. Pötschke, "Carbon nanofibers for composite applications", *Carbon*, 42, p.1153 (2004).

ORDERED ASSEMBLY OF OXIDE NANOTUBES IN A POROUS ALUMINA MEMBRANE

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1 IN-IFIMUP and Dep. Física, Rua do Campo Alegre 687, 4169-007 Porto, Portugal
2 REQUIMTE, Servico de Química-Física, Faculdade de Farmácia, Universidade do Porto, Rua Aníbal Cunha, 164, 4099-030 Porto, Portugal 3 CNFUL, Av. Prof. Gama Pinto, 2, 1649-003 Lisboa, Portugal 4 ITN, Estrada Nac. N10, Apartado 21, 2686-953 Sacavém, Portugal

The great advances in nanoscience and nanotechnology in the last decade have lead to the development of new platforms where all physical properties like size, porosity, geometry and surface functionalization can be controlled at the nanoscale. The research devoted to this field is pushed by the potential applications offered by such structures in several areas, ranging from spintronics to nanomedicine. Particularly, high aspect ratio inorganic nanoparticles have arouse great interest and shown many potentialities [1]. While in the former area, these nanomaterials appear as key components for applications in nanoscale electronics, optics and sensors, in the latter they can be used for biomedical applications such as drug delivery and bioseparations, profiting from the fact that inner voids can be filled with species, ranging in size from large proteins to small molecules.

In this work we used nanoporous alumina membranes to produce two types of oxide nanotubes: silica (SiO_2) [2] and perovskite manganites ($R_{1-x}M_xMnO_3$) [3], via the sol-gel template method. These templates can be easily fabricated using adequate anodization conditions and the pore size and interpore distance easily varied. Furthermore, their use for growth of nanotubes has enormous advantages: the possibility to build a net of aligned and ordered nanostructures, the chance to fill or functionalize their inner side without affecting their outer surface and the ability to control the dimensions required. Using this method, not only can we control the length of the nanotubes, but we can also control their diameter and thickness, allowing us to vary these characteristics along their surface.

11h55 Fri 6

We will present an optimization of the sol-gel template method using nanoporous alumina membranes. This method allowed us to obtain high quality oxide nanotubes and nanowires of SiO_2 and $La_{1/3}Ca_{2/3}MnO_3$, varying sol-gel parameters such as temperature, concentration and deposition time. The developed methods can be adequately applied to other oxides. We also present the morphological, structural and magnetic characterization of these nanoparticles.

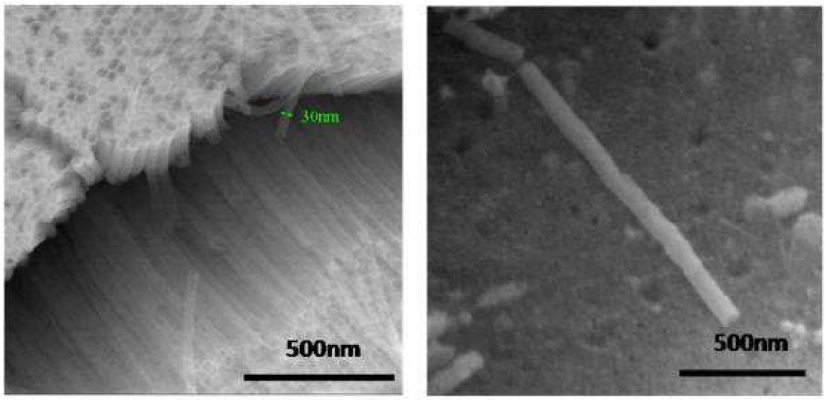

Fig. 1: SEM images of silica nanotubes and an isolated manganite nanotube obtained by the sol-gel template method.

1. S.J.Son, X.Bai and S.B.Lee, Drug Discov. Today. 2007, 12, 650.
2. D.T.Mitchell, S.B.Lee, L.Trofin, N.Li, T.K.Nevanen, H.Soderlund and C.R.Martin, J. Am. Chem. Soc.. 2002, 124, 11864.
3. P.Levy, A.G.Leyva, H.E.Troiani and R.D.Sánchez, Appl. Phys. Lett.. 2003, 83, 5247.

INVESTIGATION OF THE α TO β PHASE TRANSFORMATION OF POLY(VINILIDENE FLUORIDE) AND ITS RELATIONSHIP WITH THE MACROSCOPIC ELECTRO-MECHANICAL RESPONSE OF THE MATERIAL

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2 Centro de Biomateriales, Universidad Politécnica de Valencia, 46022 Valencia, Spain
3 Regenerative Medicine Unit. Centro de Investigación Príncipe Felipe, Autopista del Saler 16, 46013 Valencia, Spain
4 CIBER en Bioingeniería, Biomateriales y Nanomedicina, Valencia, Spain

Poly(vinylidene fluoride) (PVDF) has remarkable properties leading to electro-optics, electro-mechanical and biomedical applications. In particular its piezo- and pyro-electric properties provide possibilities for many technological applications. PVDF shows at least four crystalline phases known as α, β, *gama*, δ. The one with the best piezoelectric and pyroelectric properties is the β-phase [**?**]. This phase is obtained through a technological process involving stretching and poling of extruded thin sheets of the material in the apolar α-phase. The films obtained by this process are mostly in the β-phase, but with a small percentage of the α-phase material [1]. A detailed investigation of the α to β solid state phase transformation has been performed in order to understand the temperature and stretching conditions dependent structural and morphological variations of the polymer. Further, the influence of these changes in the macroscopic dielectric, piezoelectric and mechanical response of the material has been investigated. As a result, an optimization of the processing conditions of the electroactive β-phase of the polymer and a better understanding of the phase transformation process has been achieved.

12h15
Fri
7

[1] A,. J. Lovinger, in: Developments in Crystalline Polymers, in: I.D.C. Basset (Ed.), Applied Science, London, 1982.

QUANTUM CORRELATIONS MEDIATED BY SPIN CHAINS

A. Ferreira[1], J. M. B. Lopes dos Santos[1]

1 CFP and Dept Fisica, Faculdade de Ciencias da Universidade do Porto

This communication will describe an analytical approach for the computation of Long Distance Entanglement (LDE) mediated through one-dimensional quantum spin chains recently found in numerical studies [1]. I review the formalism [2] that allows the computation of LDE for weakly interacting probes with gapped many-body systems and show that, at zero temperature, a DC response function determines the ability of the physical system to develop genuine quantum correlations between the probes. In the second part of the talk, I show that the biquadratic Heisenberg spin-1 chain is able to produce LDE in the thermodynamical limit and that the finite antiferromagnetic Heisenberg chain maximally entangles two spin-1/2 probes very far apart. This is of crucial importance since feasible mechanisms of entanglement extraction from real solid state systems and their ability to transfer entanglement between distant parties are essential ingredients for the implementation of Quantum Information protocols, such as teleportation or superdense coding.

14h00
Fri
8

1. L. Campos Venuti, C. Degli Esposti Boschi and M. Roncaglia, Phys. Rev. Lett. **96** 247206 (2006).
2. A. Ferreira and J. M. B. Lopes dos Santos, Phys. Rev. A. **77** 034301 (2008).

GLOBAL $SO(3) \times SO(3) \times U(1)$ SYMMETRY OF THE HUBBARD MODEL ON THE SQUARE LATTICE AND ITS PHYSICAL CONSEQUENCES

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It is found that for on-site interaction $U \neq 0$ the local $SU(2) \times SU(2) \times U(1)$ gauge symmetry of the Hubbard model on a square lattice with vanishing transfer integral $t = 0$ can be lifted to a global $[SU(2) \times SU(2) \times U(1)]/Z_2^2 = SO(3) \times SO(3) \times U(1)$ symmetry in the presence of the kinetic-energy hopping term of the Hamiltonian with $t > 0$ [1]. The global $SO(3) \times SO(3) \times U(1) = [SO(4) \times U(1)]/Z_2$ symmetry is an extension of the well known $SO(4)$ symmetry of the model [2]. The generator of the new found hidden independent charge global $U(1)$ symmetry is one half the rotated-electron number of singly-occupied sites operator. The physical consequences of the new found symmetry concerning the further understanding of the unusual properties of the hole-doped cuprates are shortly presented.

14h20
Fri
9

1. J. M. P. Carmelo, S. Östlund, and M. J. Sampaio, arXiv:0802.2146.
2. C. N. Yang and S. C. Zhang, Mod. Phys. Lett. B **4**, 759 (1990).

DIVIDE AND CONQUER

Teresa Vaz Martins[1,2], Raúl Toral[2]

1 Centro de Física do Porto, Departamento de Física, Faculdade de Ciências da Universidade do Porto, Porto, Portugal
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In some nonlinear systems, the right amount of noise can enhance a coherent response to a weak external signal, by a phenomenon known as stochastic resonance [1]. It was shown that in collective systems, a similar constructive role can be played by other sources of disorder, such as diversity in the individual units [2], or competitive interactions [3].
In this communication, we address the case where disorder is induced solely by the presence of both attractive and repulsive links. We find that there is an optimal proportion of repulsive links, such that the coherent response is maximal, and we propose a mechanism to explain this resonance.
To emphasize the generality of the phenomenon, we present examples of "competitive induced resonance" in some prototypical systems. Applications can include information processing by networks of neurons with inhibitory and excitatory synapses, or simple opinion spreading models.

14h40
Fri
10

1. L. Gammaitoni et al, Rev. Mod. Phys. **70**, p. 223 (1998)
2. C.J. Tessone, C.R. Mirasso, R. Toral, J.D. Gunton, Phys. Rev. Lett. **97**, 194101 (2006)
3. T. Vaz Martins, R. Toral, "Resonance induced by repulsive links", in Visarath In et al (eds.), *Applications of Nonlinear Dynamics: Model and Design of Complex Systems*, Springer Series: Understanding Complex Systems. (2009) .

A GRAVITO-ELECTROMAGNETIC ANALOGY BASED ON TIDAL TENSORS

Luís Filipe P. O Costa[1], Carlos A. R. Herdeiro[1]

1 Departamento de Física e Centro de Física do Porto, Universidade do Porto, Porto, Portugal

According to General Relativity, the way mass curves spacetime depends on its motion. Just like the gravitational field of a mass at rest resembles, under certain conditions, the Coulomb electric field, mass currents give rise to effects which strongly resemble magnetism.
In this talk we present a new approach [1] to explore the physical analogy between General Relativity and Electromagnetism, based on tidal tensors of both theories. Our proposal goes well beyond the previous approaches found in literature, since it leads to an exact, covariant, and fully general form for the physical gravitational analogues of Maxwell's equations. It also leads to an exact and physically enlightening derivation of Papapetrou's equation for the gravitational force exerted on a gyroscope.
The tidal tensor formalism allows for a comparison between gravity and electromagnetism in terms of quantities common to both theories, making transparent the similarities and key differences between the two interactions. Among the latter the absence of gravitational induction effects (that have been predicted in the literature, e.g. [2]) analogous to the electromagnetic ones, which is shown to explain Hawking's [3] spin-dependent upper bound for the energy released when two black holes collide.
Two special cases of matching between gravitational and electromagnetic tidal tensors are discussed: one matches linearized gravitational tidal tensors to exact electromagnetic tidal tensors in Minkowski spacetime; in the other we reveal an exact matching between magnetic gravitational tidal tensors from ultra-stationary spacetimes and magnetic tidal tensors from electromagnetism in curved spaces.
Our approach clarifies some issues concerning other gravito-electromagnetic analogies commonly found in the literature: it sheds light on the debate about the limit of validity of the analogy based on linearised theory (e.g. [4]), and solves conceptual difficulties in the physical interpretation of the analogy based on the splitting of the Weyl tensor in electric and magnetic parts (eg. [5]), clarifying at the same time the relationship between these two analogies.
It also achieves an unification within gravito-electromagnetism, by revealing that the analogy known from the linearized theory originates from the same fundamental principle as the exact mapping (via the Klein-Gordon equation) between ultra-stationary spacetimes and magnetic fields in curved manifolds [6, 7].

15h00
Fri
11

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TWO LIMITS OF THE DOUBLE KERR SOLUTION

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The Double-Kerr solution can be generated using solution-generating techniques, that allows us to reach a new stationary and axisymmetric vacuum solution from an old one. It turns out that this solution is not regular, i.e. there is a strut between the black holes preventing the collapse of the system.

15h20 Fri 12

In this talk I will explore two particular limits of this solution where the black holes have equal mass and either the same or opposite angular momentum. In particular it is possible to show that, in both cases, 1) for fixed mass and angular momentum, the angular velocity of the two black holes decreases as they approach one another; 2) the extremality limit $|J|/M^2$ varies with the distance and may even be larger than one. I will also analyse the merging of the ergo-regions and the force associated to the strut (that includes the contribution of the spin-spin force between the black holes).

FIBRE BRAGG GRATINGS IN SUSPENDED CORE FIBRES

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2 Departamento de Física, FCUP, Rua do Campo Alegre 687, 4169-007 Porto

The silica suspended-core fibre is a micro-structured fibre consisting on a silica core surrounded by a hollow cladding, where the core is suspended through silica bridges. This special kind of optical fibre has been used for many sensing applications like gas sensing [1, 2], refractometric measurements [3], etc.
In this work we explore further the sensing properties of suspended-core fibres considering fibre Bragg gratings photoimprinted into these fibres. We use two-beam grating inscription with a DUV-femtosecond laser source to produce FBGs in both, germanium doped and pure silica optical fibres.
After achieving Bragg gratings fabrication and characterization in suspended core fibres, the goal is to study their application in sensing. The sensor response to physical parameters such as strain, temperature, refractive-index and pressure is investigated considering gratings obtained with different fabrication parameters.

16h50 Fri 13

The application of these grating structures will be focused on pressure sensing. The temperature sensitivity of the pure silica fibre is expected to be small when compared to that of the germanium doped fibre. Therefore, this characteristic can be used to obtain a sensor which is substantially insensitive to temperature, while it is expected to have a substantial sensitivity to pressure. Optimization issues will be considered to obtain a versatile sensing head for temperature independent pressure measurement.

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SPECTRAL AND SPATIAL MODE CONTROL IN SELF-SEEDED SEMICONDUCTOR DISK LASER USING OPTICAL FEEDBACK FROM FIBER BRAGG GRATING

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2 Inesc-Porto, Unidade de Optoelectrónica e Sistemas Electrónicos,Porto, Portugal
3 Optoelectronics Research Centre, Tampere University of Technology, Finland

We report a semiconductor disk laser with mode control based on self-seeding technique using the optical feedback from a partially reflecting fiber Bragg grating[1]. In this scheme the operation wavelength is locked to the Bragg wavelength and results in a high-extinction narrow-line operation. This study demonstrates that feedback signal spatially and spectrally filtered by the single-mode fiber incorporating Bragg grating is an effective instrumental for suppression of the diffraction-limited beam distortions that occur due to thermal lensing in high-power disk lasers[2]. It was found that injection of the fundamental Gaussian mode from a single-mode fiber into the laser cavity of the disk laser improves beam quality, i.e. reduces M2-factor and allows to extend the operation with a diffraction-limited beam to higher output powers.

17h10
Fri
14

1. A. Harkonen, S. Suomalainen, E. Saarien, L.Orsila, R.Koskinen, O. Okhotnikov,S. Calvez and M. Dawson, " 4W single-transverse mode VECSEL utilizing intra-cavity diamond heat spreader,"IEEE Electron.Lett. 42, pp. 693-694 (2006)
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GAS VUV PHOTOSENSORS OPERATING FACE-TO-FACE AT HPXE

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The operation of two photosensors operating face-to-face having a high pressure xenon medium in between is presented. Each photosensor consist in a CsI- MicroHole and Strip Plate (MHSP) operating within the pure xenon medium. To produce the VUV scintillation photons, a cluster of 7 stainless steel grids having a 1.3 mm gap between them, are placed in the xenon medium and a voltage is applied between grids to establish an electric field higher than the xenon excitation threshold. The scintillation is triggered by the electron cloud produced in xenon under x- or γ-ray interactions. The interaction position of the x- or γ photons in the xenon can be determined by weighing the signal amplitude of both photosensors. Experimental studies of the interaction position along the xenon gap, in the direction perpendicular to the photosensors as well as the photosensor collection efficiency as a function of gas pressure will be presented.

17h30
Fri
15

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2. F. Amaro, J. F. C. A. Veloso, A. Breskin, R. Chechik, J. M. F. dos Santos, Journal of Instrumentation **1**, P04003 (2006).
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DEVELOPMENT OF SIMULATION PLATFORMS FOR MPGDS

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Today, simulation of the physical processes and response parameters in radiation detectors is an important issue for cost and time saving in radiation detectors development as well as for the determination of the optimal operation parameters.
Two different platforms, GEANT4 and GARFIELD, are used for different purposes, using continuous and discrete calculations, respectively. For the Micro Pattern Gaseous Detectors (MPGDs) needs, GEANT4 presents a limitation in low energy charged particles transport, while GARFIELD, althought have not the full capabilities of GEANT4, fullfills the low energy requirements. In this work, developments in the direction of integrate both platforms envisaging the use of full capabilities of each one are being done.
GARFIELD is limited to charge transport. New developments in MPGDs require simulation on the scintillation properties, produced in electron drift across the gas. For this purpose, new code for scintillation simulation is under development.
This work is being performed under CERN-RD51 collaboration.

17h50
Fri
16

1. http://www.geant4.org/geant4/
2. http://garfield.web.cern.ch/garfield/
3. https://espace.cern.ch/test-RD51

GAS DETECTION SYSTEM BASED ON WAVELENGTH MODULATION SPECTROSCOPY AND HOLLOW-CORE PHOTONIC CRYSTAL FIBRES SENSING HEADS

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An optoelectronic system for detection and monitoring of methane gas has been developed and implemented. The signal processing technique used in the proposed system is based on Wavelength Modulation Spectroscopy (WMS). When associated with the hollow core photonic bandgap fibres, this scheme revealed an effective way to measure gas concentration. Aiming the optimization of the sensing head design, the methane diffusion time inside a hollow-core fibre was evaluated. An error of 2.8 % between experimental and theoretical values was obtained, thus validating the adopted model. These results led towards the implementation of a gas sensing portable unit for remote methane monitoring applications.

18h10
Fri
17

1. J. P. Carvalho, F. Magalhães, O. V. Ivanov, O. Frazão, F. M. Araújo, L. A. Ferreira, J. L. Santos, Proc. of SPIE 6619, 66191 (2007)
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RATIOMETRIC SENSING AND IMAGING WITH CDTE SEMICONDUCTOR NANOCRYSTALS FOR BIOMEDICAL APPLICATIONS

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CdTe quantum dots (QD) with different sizes, corresponding to different emission wavelengths, were synthesized and capped with mercaptopropionic acid (MPA) to become water soluble and pH sensitive. Such a nanostructure can be the basis for a variety of sensing applications or imaging techniques [1]. In this work we present an optical fiber pH sensor based on the sol-gel immobilization of pH sensitive CdTe QDs and an application of pH sensitive quantum dots in analytical imaging. The luminescence properties of the capped QDs, luminescence spectrum, emission intensity and lifetime were characterized in environments with different acidity. It was observed that increasing acidity introduced a shift towards higher wavelengths along with the quenching of the luminescence intensity and the decrease of the excited state lifetime. Sigmoidal responses in the range of pH=2 to pH=11, with pKa around 6, make these nanoparticles very attractive for sensing and imaging applications. For analytical imaging A confocal microscope was used to create a map of pH in a solution with QDs. Dual channel ratiometric technique was used to differentiate between different pH regions.

18h40
Fri
18

[1] Pedro Jorge, Manuel Antonio Martins, Tito Trindade, José Luís Santos, and Faramarz Farahi. Optical Fiber Sensing Using Quantum Dots. Sensors. 2007, 7, 3488-3534.

SLOTTED MULTIMODE INTERFERENCE DEVICE FOR CHEMICAL AND BIOCHEMICAL SENSING

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2 INESC Porto, Porto, Portugal
3 University of North Carolina at Charlotte, Charlotte, United States of America

Recent years have seen the growing need for monitoring various physical, chemical and biological parameters, in diverse applications, from healthcare to environmental sciences.
We present a slotted multimode interference (MMI) device [1, 2] as a refractometer sensor [3] with possible application to chemical and biochemical sensing. This device can be used for absolute measurements of refractive index (r.i.) as well as sensitive differential measurements. Its operating range of r.i. measured can be tuned for different liquids, by proper choice of fabrication materials or geometry. We estimate a sensitivity of 5 x 10^{-5} on refractive index measurement, based on a threshold detection limit of one percent in the normalized differential output. The sub-micrometer wide slots enhance the measurement sensitivity while reducing device size, for a compact sensing architecture.

19h00
Fri
19

1. L.B. Soldano and E.C.M. Pennings, J. Lightwave Technology, 13(4), 615-627 (1995).
2. D.M. Mackie and A.W. Lee, Applied Optics, 43(36), 6609-6619 (2004).
3. M. Mayeh, J. Viegas, P. Marques, J.L. Santos, F. Farahi, EWOFS 2007, 2007

THE NUMBER OF COLOURS AND THEIR DISTRIBUTION FOR NORMAL AND COLOUR DEFICIENT OBSERVERS IN NATURAL SCENES

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19h20
Fri
20

Although the total number of discernible colours in natural scenes has been estimated from physical data, the distribution of colours has received little attention. To address this issue, an analysis was made of hyperspectral images taken from a database of 50 urban and rural scenes. The colour volume of the database was computed by expressing each pixel of each image in CIELAB space for normal and colour deficient observers. To derive the distribution of colours, the volume was segmented into just distinguishable sub-volumes, approximated by unit cubes, with each non-empty sub-volume assumed to represent one discernible colour and its pixel population the total number of times it occurs over the 50 scenes. It was found that colour deficient observers has a considerable impaired colour vision of about 7%, 50% and 45% for dichromats, protanomalous and deuteranomalous respectively, and that for normal observers the fraction of discernible colours expressed as a function of occurrence could be described by a negative power-law and that most discernible colours appeared only rarely.

Saturday, January 17

ADVANCES IN MAGNETIC AND MAGNETOCALORIC STUDIES

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2 Departamento de Física and IFIMUP, Faculdade de Ciências, Universidade do Porto, Portugal

The magnetocaloric effect [1] is a common property of all magnetic materials, resulting from the coupling between the magnetic degrees of freedom and lattice. From thermodynamics, the change of magnetic entropy due to a change in applied magnetic field will induce a temperature change (under adiabatic conditions) or heat transfer (under isothermal conditions).
Our work focuses on the study of magnetic and magnetocaloric properties of materials, and in this scope we shall present the main conclusions of some of the work in progress. These include studies in second– and first–order magnetic phase transition manganites [2] and also percolation and spin reorientation phenomena in PrNiCo hard magnets [3].
The use of models such as the Landau theory of phase transitions and the Ben–Rodbell magneto–volume interactions on the Weiss molecular mean–field model will also be discussed. Landau theory allows us to study the magnetoelastic coupling influence on the magnetocaloric effect in ferromagnetic materials [2,4], while the Bean–Rodbell model is the basis of a new scaling method [5]. The existence of metastable states in first–order magnetic phase transitions and their effect on estimating the magnetocaloric effect is also discussed [6].

10h00
Sat
1

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[**3**] D. L. Rocco, J. S. Amaral, J. V. Leitao, V. S. Amaral, M. S. Reis, R. P. Fernandes, J. P. Araújo, A. M. Pereira, P. B. Tavares, N. V. Martins and A. A. Coelho, Phys. Rev. B., in press.
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[**6**] J. S. Amaral and V. S. Amaral, Appl. Phys. Lett., accepted for publication.

STRUCTURAL AND MAGNETIC CHARACTERIZATION OF LASRMNO$_3$ THIN FILMS DEPOSITED BY LASER ABLATION

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In recent years, the rare-earth manganites exhibiting colossal magnetoresistance (CMR) have been attracting much scientific and technological interest. In particular, in the perovskite-type lanthanum strontium manganate ($La_{1-x}Sr_xMnO_3$: LSMO) system the Curie temperature can attain relatively high values by changing the Sr concentration. Combined with its CMR characteristics, this then makes it a promising material for room-temperature magnetic sensors, recording devices or bottom electrode in the fabrication of ferroelectric memories. Here, thin films of LSMO were prepared by pulsed laser ablation on (001)MgO and (001)$SrTiO_3$ substrates and their structural, electrical and magnetic properties were characterized. The results show that the films were composed by $La_{0.67}Sr_{0.33}MnO_3$ with a perovskite type structure. They were oriented, presenting a (001) preferred growth direction. The determined Curie temperature was $T_C \sim 280$ K for the films on MgO and $T_C \sim 340$K for the films on $SrTiO_3$. The magnetic and electrical resistivity measurements indicate that, when the films are prepared under a low oxygen cool down pressure, a reduction of the Curie and the metal-insulator transition temperatures occurs due to the formation of magnetic inhomogeneneous films, where clusters of a metallic phase are mixed in a magnetically disordered insulating matrix. By fitting the low angle X-ray reflectivity curves, with suitable models, it was observed that these thin films were chemically inhomogeneous with an oxygen deficiency in bulk when compare with the film/air interfacial region.

10h20
Sat
2

CONTRIBUTIONS TO THE MAGNETIC ANISOTROPY IN $BATIO_3$-$COFE_2O_4$ NANOGRANULAR COMPOSITE FILMS

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Materials presenting a coupling between the electric and magnetic degrees of freedom have been attracting much scientific and technological interest. By combining a piezoelectric ceramic and a magnetostrictive material the elastic interactions between the phases provide the coupling mechanism inducing a magnetoelectric behavior. Here, nanocomposites of cobalt ferrite ($CoFe_2O_4$-magnetostrictive) dispersed in a barium titanate ($BaTiO_3$-piezoelectric) matrix were prepared by laser ablation and the influence of the stress on the magnetic anisotropy of the films was characterized. The films were polycrystalline and composed by a mixture of tetragonal-$BaTiO_3$ and $CoFe_2O_4$ with the cubic inverse spinel structure. The lattice parameter of the $CoFe_2O_4$ phase was under compressive strain that relaxed as its concentration progressively increased. A magnetic anisotropy that favored the orientation of the magnetization in the direction perpendicular to the plane of the films was observed, with a characteristic anisotropy field H_A that decreased with increasing cobalt ferrite concentration. The values of the anisotropy field contributions, including the shape (H_d), magnetocristaline (H_K) and stress (H_σ) anisotropies were determined and compared. It was found that magnetic anisotropy of the films was stress induced in its origin and that the decrease of the anisotropy with increasing $CoFe_2O_4$ concentration was due to the relaxation of the stress in the nanocomposites.

10h40 Sat 3

MAGNETIC AND STRUCTURAL PHASE DIAGRAM OF $HO_5(SI_XGE_{1-X})_4$ SYSTEM

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2 NSSD ORNL, PO BOX 2008 MS6475, Oak Ridge, TN 37831-6475 USA.
3 Institut Laue-Langevin, Boýte Postale 156, 38042 Grenoble Ce´dex 9, France
4 Instituto de Nanociencia de Aragón, Universidad de Zaragoza, 50009 Zaragoza, Spain

The quest for novel magnetic materials with composition $R_5(Si, Ge)_4$ for magnetic refrigeration applications is a topic of intense research in the last years [1].
In this work we contribute to unveil the origin of the quite large magnetic effects observed in this family of compounds, presenting a systematic study of the magnetic, elastic and structural properties of $Ho_5(Si_xGe_{1-x})_4$ in its whole compositional range 0<x<1 [2]. The proposed magneto-structural phase diagram is quite similar to the one found for the Gd and Tb family members, showing a strong correlation between the crystalline structure and magnetism. Our study also shows that in contrast with the Er, Gd and Nd systems, the Ho compounds, which exhibit a monoclinic phase at room temperature, do not present a magnetostructural transition. We found that the crystal structure of $Ho_5(Si_xGe_{1-x})_4$ at room temperature depends only on the ratio between the radii of the magnetic (rR) and non-magnetic (rT) atoms. Finally we present the temperature dependence of the magnetic structure in different regions of the phase diagram obtained by neutron diffraction.

11h00 Sat 4

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2. A.M. Pereira, C. Magen, P.A. Algarabel, L. Morellon, M.R. Ibarra, C. Marquina, J.B. Sousa and J.P. Araújo, Phys. Rev. B 77, 134404 (2008).

RAMAN SCATTERING STUDY IN $EU_{1-X}Y_XMNO_3$ CERAMICS

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2 Centro de Química. Universidade de Trás os Montes e Alto Douro. Apartado, 1013. 5001-80, Vila Real – PT.

The magnetoelectric effect has been found in some rare-earth manganites, having antiferromagnetic order. In these materials, coupling between magnetic order and lattice distortions can induce a low temperature ferroelectric state and give rise to a magnetoelectric effect [1].
However, some pure rare-earth manganites do not exhibit any magnetoelectric coupling. This is the case of $EuMnO_3$, which presents an IC magnetic order below T_N=48 K and a canted antiferromagnetic one below 42 K. Nevertheless, the of isovalent doping the trivalent A-site in $EuMnO_3$ by Y^{3+} enhances the magnetoelectric effect in mixed compounds $Eu_{1-x}Y_xMnO_3$ [2]. These systems offer the possibility to continuously control the A-site volume in order to tune the corresponding multiferroic phases without additional influence of the rare earth magnetic moment.

11h40
Sat
5

In this work, we present a systematic study of the lattice dynamics in $Eu_{1-x}Y_xMnO_3$ with $0 < x < 0.5$, using Raman Spectroscopy, in the temperature range 300 K - 9 K. In order to gain a better knowledge about the structural parameters changes induced by the magnetic ordering via the coupling between phonons and magnetic moments, we have analyzed in detail the temperature dependence of the phonon parameters across the magnetic phase transitions, in correlation with the anomalous behavior observed in the temperature dependence of the electric and magnetic susceptibilities. The experimental results will be correlated with the variation of the ionic radii at the A-lattice site and deformations of the MnO_6 octahedra, which are induced by the isovalent substitution.

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TEMPERATURE DEPENDENT TRANSPORT PROPERTIES OF MGO-BASED ULTRA-THIN MAGNETIC TUNNEL JUNCTIONS: EXPERIMENT AND MODELING

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Magnetic tunnel junctions (MTJs) [1,2] with thin crystalline MgO(001) barriers displaying large tunnel magnetoresistance (TMR) and low resistance-area product ($R \times A$) will likely be used as the next generation sensors in read heads of ultrahigh-density hard drives [3,4]. However, the thin insulating barrier may result in the presence of metallic pinholes joining the two electrodes. Here we study the transport properties of thin MgO-based low resistance MTJs (barrier thickness $t = 7.5$ Å), deposited by magnetron sputtering, with ($R \times A$) values of $\sim 40\ \Omega\mu\text{m}^2$, reaching TMR values of $\sim 60 - 75$ % at room temperature. We performed temperature-dependent (300 – 20 K) resistance (R) measurements and observed different behaviors for different magnetic states: positive dR/dT for the parallel (P) state, attributed to the presence of pinholes in the barrier, but a mixed character in the antiparallel (AP) state, with dR/dT changing from negative to positive with decreasing temperature. This indicates an interesting competition between tunneling and metallic transport in the studied samples. To explain this transport behavior, we developed a simple model with the two conducting channels, tunnel and metallic, in parallel. The model assumes a linear variation of the electrical resistance with temperature for both conducting channels and its dependence on the MTJ magnetic state (P and AP). The modeled results show that the sign of dR/dT does not give an indication of the dominant conductance mechanism and that the crossover temperature at which dR/dT changes sign depends strongly on the linear electrical resistancetemperature coefficients. We performed fits to our experimental $R(T)$ data, using the proposed model, and observed that such fits reproduced the data quite well, illustrating the validity of the model.

12h00
Sat
6

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FERROMAGNETISM VS. LOCAL STRUCTURE IN TRANSITION METAL DOPED WIDE-GAP SEMICONDUCTORS

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Magnetically doped semiconductors (dilute magnetic semiconductors - DMS) are seen as strong candidates to make use of the carriers spin in spintronic devices [1]. Latest results of both experiment and theory are driving the research focus towards wide-gap semiconductors doped with $3d$ transition metals [2]. However, any attempt to understand the observed room temperature ferromagnetism, something which still remains far from being accomplished, must start from a detailed structural understanding of the systems, in particular, a quantitative knowledge of the (magnetic) impurities lattice sites.
We present preliminary analysis of recent emission channeling experiments on the lattice location of ion-implanted Fe, Co and Mn in ZnO and GaN, carried out at the CERN-ISOLDE facility. Together with results on the magnetic properties, by means of SQUID magnetometry, and structural (disorder) characterization, by means of Raman spectroscopy, these experiments pave the way for the research to follow.

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Poster session

THIN-FILM SILICON SOLAR CELLS DEPOSITED ON FLEXIBLE SUBSTRATES

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Pos 1

Flexible thin film silicon photovoltaics are usually done on low temperature plastic substrates or on stainless steel foil. This project will compare both approaches, in the light of subsequent integration with textile products for home and outdoor, clothing, and the automotive industry.
This PhD project entails the study and deposition of amorphous and nanocrystalline silicon solar cells by chemical vapour deposition techniques at high deposition rates ($\geq$0.5 nm/s) and substrate temperatures of 150^{o}C and 200^{o}C. Progress on such devices will then enable the fabrication of tandem solar cells, within the context of low cost and roll-to-roll enabled substrates. The project will conclude with the fabrication of small flexible modules ($\sim$10 cm^{2}aperture area), using external collaboration for the laser scribing steps.

THIN FILM DEPOSITION OF NI-MN-GA ALLOY ONTO SI AND PZT BUFFER SUBSTRATES BY RF MAGNETRON SPUTTERING AT ROOM TEMPERATURE

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Pos 2

RF Sputtering deposition of Ni-Mn-Ga ferromagnetic shape memory films alloy onto plain Si substrates and Si with LNO/PZT ferroelectric buffer was performed. The controlling parameters RF power ratio and Argon pressure in the chamber were varied to establish the most favourable parameters to perform a successful film deposition at low temperature conditions (near room temperature).
Extensive characterization by SEM, EDS, AFM and XRD of the NMG films show good surface quality and crystallization of the film in high textured $(110)_c$ martensitic tetragonal phase. Compositions of the films ware varied according to the relative position of the substrate to deposition axis. SQUID and magneto-optic measurements showed a typical hysteresis, anisotropy and a spin glass like behaviour with low magnetization in comparison with a bulk NMG alloy.
This low temperature fabrication is very promising in order to minimize oxygen diffusion effects between NMG and PZT interfacing surface, to improve magnetoelectric applications [1] [2]: ferromagnetism and shape memory effect characteristic of the martensitic phase transition coupling to a ferroelectric layer.
The work was performed within EC-funded project "Multiceral" (NMP3-CT-2006-032616).

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GRADED PZT FILMS PRODUCED BY PULSED LASER DEPOSITION

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Ferroelectric films have attracted much attention in recent years because of their suitability for use in electronic devices. Ferroelectric films with a composition gradient (gradient normal to the substrate plane) were found to be very interest subject, because of their remarkable properties. In this work, graded PZT films, containing three layers with different Zr/Ti ratios (55/45, 65/35 and 92/8), were prepared on $Pt/TiO_2/SiO_2/Si$ substrates by pulsed laser deposition technique. X-ray diffraction analysis showed formation of pure perovskite phase after annealing at 650 ^oC. The dielectric response of the graded structure was studied as a function of frequency (from 10 Hz up to 2 MHz) and temperature (from room temperature up to 419 ^oC) using impedance spectroscopy. The analysis revealed that the bulk grain relaxation was the dominant relaxation process over the frequency and temperature range studied. The hopping conduction obeying the universal power law and an exponent equal to 0.88 was observed to dominate in ac conductivity over the entire frequency range at room temperature. At higher temperatures the relaxation spectrum was found to be much influenced by the increased dc conductivity related to motion of oxygen vacancies within the bulk. The results of XRD, Raman spectroscopy, morphology, compositional and ellipsometric studies will be also presented and discussed.

Pos 3

GE NANOCRYSTALS FOR FLASH MEMORIES: A QUANTITATIVE STUDY OF SIZE DISTRIBUTION

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Ge NCs have attracted considerable attention because of their potential applications in nonvolatile memory and integrated optoelectronics. A number of groups have already proposed integrate flash memories based on Ge NCs embedded SiO2 matrix [1]. Since Al2O3 presents a high dielectric constant comparatively to SiO2, it is a good candidate to replace silica in flash memory systems, and therefore improve their performances [2]. Moreover, Al2O3 presents good mechanical properties, and supports high temperature, which leads it to be an ideal material for Si processing conditions. However, a few studies have been reported on Ge NCs embedded in Al2O3 matrix [3].
Ge NCs embedded in alumina were prepared using the RF- magnetron sputtering technique, and after the films were annealed in order to improve the cristallinity of the Ge phase and achieve control over the NCs size [4]. With the aim to study the cristallinity and distribution of the Ge NCs size the Raman, X ray diffraction and high resolution transmission electron microscopy (HRTEM) techniques were used. NCs sizes were deduced from X ray and Raman spectra using the Scherrer equation [5] and Fauchet and Campbell model [6], respectively. Statistical average diameters were obtained by HRTEM pictures.
We observed that for smallest Ge NCs, the sizes obtained are similar for different techniques, but for larger NCs exists discrepancy between the XRD and Raman. The reason for this discrepancy is not clear at present. However, a possible explanation is the compressive stress [7] exerted on Ge NCs due to existence of Al2O3 matrix.

Pos 4

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AB-INITIO CALCULATIONS ON MANGANITES: HYPERFINE QUANTITIES FOR INTERPRETATION OF PERTURBED ANGULAR CORRELATION EXPERIMENTS, AND OTHER PROPERTIES.

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Pos 5

The manganites have received a lot of attention in the last years due to the exhibited complex behavior, with interplay of magnetic, orbital, charge and structural orders, unusual phase diagrams and response to different conditions. The deeper understanding of these materials may lead to a better comprehension of other complex oxides. Furthermore, there are potential technological applications due to e. g. colossal magnetoresistance and multiferroism. The density functional calculations of materials have also been subject to developments in the last years. The full potential (L)APW+lo method implemented in the Wien2k code is particularly accurate, allowing the calculation of sensitive properties in transition metal oxides. This method is applied in the case of manganites. We report mainly electric field gradient and magnetic hyperfine field calculations, comparing with perturbed angular correlation experimental results, with substitutional impurities to account for influence of the radioactive probe $ˆ{111}$Cd. Other quantities are also obtained theoretically, providing further insight.

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A NEW INTERROGATION SCHEME FOR SURFACE PLASMON RESONANCE SENSORS BASED ON FIBRE BRAGG GRATINGS

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Pos 6

In this work we present a new configuration of a refractometric sensor for aqueous solutions based on the combination of the surface plasmon resonance (SPR) with fibre Bragg gratings (FBG). Two FBGs are selected for having the SPR wavelength between their Bragg wavelengths. The parameter under analysis is the normalized power, calculated from the power reflected by the two FBGs, as it varies when the refractive index of the external medium changes due to the variations of the SPR position. The information given by the two FBGs will increase the sensitivity of the sensor compared with respect to that obtained with the usual method of tracking the spectral transmittance minimum. The reachable resolution with this scheme is also improved. This scheme is tested out with a double-layer uniform waist tapered fibre (DL-UWT) for the experimental measurements.

OPTICAL WAVEGUIDES AND BRAGG GRATINGS PATTERNED ON SOL-GEL DERIVED ZIRCONIUM MODIFIED DI-UREASILS USING LASER DIRECT WRITING

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Organic-inorganic hybrid materials with good optical and mechanical properties find interesting applications in the fields of integrated optics, leading to low cost and high quality components, including channel waveguides and Bragg gratings [1]. Sol-gel derived organic-inorganic hybrids containing methacrylic acid modified zirconium tetrapropoxide, classed as di-ureasil-zirconium oxo-cluster hybrids, have been prepared and structurally characterized by X-ray diffraction, small-angle X-ray scattering, Fourier transform infrared and Raman spectroscopies, ^{29}Si and ^{13}C nuclear magnetic resonance and atomic force microscopy [2]. These zirconium modified di-ureasil hybrids were spin coated as thin films in glassy substrates and molded as transparent and shape controlled monoliths. Laser direct writing process was used to create monomode channel waveguides, Bragg gratings, and Fabry-Perot cavities on bulk materials. The channel waveguide characterization as performed in order to determine the refractive index gradient within the guiding region; a Gaussian section located below the patterned channel was evaluated and modeled with a maximum index contrast of 2.43×10^{-5}. The UV patterned diffraction gratings with a pitch of 525 nm were superimposed on the waveguide channels forming Fabry-Perot cavities. The reflection coefficient of the Fabry-Perot cavity reflectors was 0.042 with a free spectral range (FSR) value of 35.6 GHz [2,3].

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HYBRID SOL-GEL INTEGRATED OPTIC BEAM COMBINERS FOR ASTRONOMICAL INTERFEROMETRY

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Pos 8

Astronomical interferometry has overcame the limited angular resolution of a single telescope. The beam combiner is a critical function in an astronomical interferometer, especially when the number of telescopes increases. Integrated optics (IO) is a novel technology used for beam combination. Compactness, stability and spatial filtering are some advantages of IO.
In our group IO devices are made by hybrid Sol-Gel technology and are optimized for astronomical J-band ($\lambda \simeq 1.3\mu m$). A UV laser direct writing unit is used to fabricate the mask [1]. Coaxial two beam combiner (C2BC), C3BC and C4BC and a multiaxial two beam combiner (M2BC) are designed and fabricated [2]. An interferometric set-up employing polarization maintaining fibers are used to characterize the fabricated devices. The characterization resulted visibilities better than 90% and 98% for M2BC and for the C2BC. Also visibilities better than 94% and 90% for all combination pairs of respectively a C3BC and a C4BC have been measured using an SLD ($\lambda_0 = 1.26\mu m$, FWHM 50nm) as the source. These results demonstrate that hybrid sol-gel technology can produce devices with high quality, opening the possibility of rapid prototyping of new designs and concepts for astronomical applications.

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EFFECT OF FIBER TAPERING IN MODAL LPG-BASED MACH-ZEHNDER INTERFEROMETERS FOR REFRACTIVE-INDEX SENSING

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Pos 9

In this work, an LPG-based Mach-Zehnder modal interferometer with a fiber-taper section between the two LPG is studied as a sensing structure for measuring environmental refractive index. To interrogate this sensing device, coherence addressing and pseudo-heterodyne processing were used. A fiber taper was made between the two LPGs to improve and tailor the sensitivity of the sensor. Experimental results show that the sensitivity to external refractive index increases with the length of the taper and that the sensitivity enhancement is stronger for lower order cladding modes.

LASER DIRECT WRITING UNIT FOR RAPID PROTOTYPING OF INTEGRATED OPTICAL MICRO DEVICES

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In recent years, there has been an intensive search of cost efficient techniques for integrated optic device fabrication. One approach with recognized potential is laser direct writing upon photosensitive materials, which permits the fabrication of devices using equipment of modest cost and allows a large material diversity. In addition, the approach allows the device structure to be defined by selective polymerization under exposure to UV light. This technique avoids the use of expensive and time consuming dry-etching processes, therefore reducing the cost and the processing time.

Pos 10

In this work the fabrication of microscale integrated optical devices produced by a laser direct writing technique is described. The practical aspects related to the laser writing unit are mentioned, together with the characterization of the writing process on different media, like hybrid sol gel, photoblank masks or photoresist films. This is the first step towards laser fully written devices.

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OPTIMIZATION METAHEURISTICS BASED UPON THE GENETIC ALGORITHM FOR HARD PROBLEMS IN TELECOMMUNICATIONS

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Three hard optimization problems in the context of optical communications systems are presented: (i) the gain equalization of distributed Raman amplifiers, (ii) the minimization of the impact of Four-Wave Mixing (FWM) crosstalk in a Wavelength Division Multiplexing (WDM) ring, (iii) the optimization of the apodization profiles of Super Structured Fiber Bragg Gratings (SSFBG) for Optical Code Division Multiple Access (OCDMA) applications. All the mentioned problems involve multivariable and multifunction optimization and consequently the trivial derivative based optimization methods are not applicable. A developed hybrid Genetic Algorithm was used in order to attain a suitable solution in a reasonable time compatible with laboratorial experiments. The method follows a combination of the GA with the Nelder-Mead method in order to improve the number of function evaluations by a factor of two. For problems (i) and (ii), the obtained results were confirmed with experiments.

Pos 11

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DELOCALIZED VERSUS LOCALIZED MAGNETIZATION REVERSAL IN TEMPLATE-GROWN NI AND NI80FE20 NANOWIRES

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A huge effort is being made on the development and study of the magnetization (M) reversal processes of arrays of highly ordered magnetic nanowires, due to their potential applications in a wide range of areas, particularly perpendicular recording media. We electrodeposited high aspect ratio Ni and NiFe nanowires in nanoporous alumina templates (pore diameter 35 nm and separation 100 nm). To understand the magnetization reversal mechanisms active in our arrays, we performed SQUID measurements as a function of temperature (3505 K). NiFe nanowire samples showed typical single-domain behavior dominated by the strong shape anisotropy, while Ni nanowires exhibited an almost isotropic behavior. In both cases, a strong H_C deviation from the expected theoretical value assuming delocalized magnetization reversal is seen. A M-reversal triggered by thermal-activation over an energy-barrier model [1,2] is used to compare the theoretical prediction of delocalized coherent/incoherent rotation to a more realistic domain nucleation process. Taking into account the measured effective anisotropy we extracted the effective volume (V_{eff}) for M-reversal. Assuming a delocalized process, the obtained V_{eff} is much smaller than the expected $V_{delocalized}$=$V_{cylinder}$. Instead, when we assume domain nucleation, we get V_{eff} $<\sim$ Vπ-domain. Thus, the M-reversal energy barrier is smaller than the predicted for nucleation in a finite volume of an infinite cylinder. This is compatible with the fact that we have finite and imperfect wires (defects and cracks) that introduce different local anisotropies favoring the existence of domain wall nucleation sites.

Pos 12

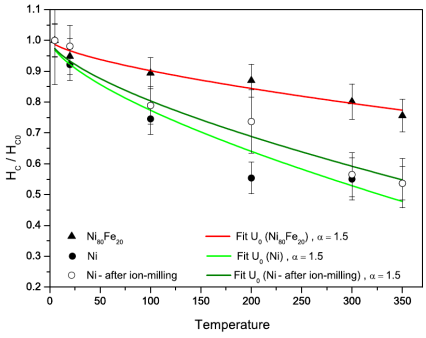

Fig. 1: Temperature dependence of H_c for $Ni_{80}Fe_{20}$ (triangles), Ni (closed circles) and Ni after milling (open circles) nanowires. Fits to to the experimental data, with $\alpha = 1.5$, illustrated by solid lines. As fitting parameter we use U_0: $U_0^{Ni_{80}Fe_{20}} = 83000$ K, $U_0^{Ni} = 25000$ K and $U_0^{Ni-milled} = 28000$ K.

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GLOBAL ATMOSPHERIC ENERGETICS IN THE WAVE NUMBER DOMAIN

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Pos 13

The global atmospheric circulations represented by ERA-40 [1], NCEP-R2 [2] and JRA-25 [3] reanalysis datasets are analyzed and intercompared in terms of global atmospheric energetics in the domain of wave number [4]. Energetics computations are based on 6-hourly values of the atmospheric fields of temperature, geopotential height and zonal, meridional and vertical winds at the available pressure levels with horizontal resolution of 2.5 ° Latitude by 2.5 ° Longitude. On the whole, the global energy cycle is consistent amongst the three datasets. The peaks and slopes in the spectra of the various components in the energy cycle agree rather well between the three reanalysis. Differences are found between the three reanalysis, mostly in the magnitude of energy or energy transformation at each wave number, generally following the relation ERA-40 > JRA-25 > NCEP-R2. The best agreement between the three datasets is found during northern winter. In the other seasons, the differences between the three datasets increase substantially in some cases, specially in northern summer. The energy source in the nonlinear wave-wave interactions of kinetic energy, $L(n)$, has a narrower spectral range in NCEP-R2 than in the other datasets. The spectra show a rapid decrease for short waves in NCEP-R2 ($n = 35$) and ERA-40 ($n = 63$), probably due to filtering, while such decrease is absent in JRA-25.

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