35 – Commensurability effects in magnetic properties of superconducting thin films with periodic submicrometric antidots

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Elastic media interacting with a periodic pinning potential represents the behavior of a number of different physical systems, as for example charge and spin density waves, adsorbed atomic layers in periodic substrates, and vortex lattice (VL) in type II superconductors with artificial periodic pinning centers. One of the main features that results in the case of VLs is the presence of commensurate or matching field effects, where pinning or critical current seems to increase, but the mechanism remains still an open question. In this work we examine the response of superconducting vortices interacting with a regular array of sub micrometric "antidots" or holes and with non periodic weak pinning centers. *ac* and *dc* magnetic properties in Nb thin films ($\sim$ 100 nm thick), deposited on porous anodized aluminum oxide (AAO) substrates with pores $\sim$ 40 nm in diameter, self-assembled in triangular array with mean distance $\sim$ 100 nm, are compared with those obtained for a reference Nb continuous film. Origin and nature of commensurability or matching field effects, observed both in *ac* and *dc* experiments for the sample with antidots, is discussed within the picture of single/multiquanta pinned flux, interstitial vortex pinning and Little and Parks T_C suppression effects.

36 – Pomeranchuk Instabilities in Lattice Systems

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We describe a recently developed procedure for detecting Fermi liquid instabilities which is an extension of the analysis of Pomeranchuk to two-dimensional lattice systems. The method is very general and straightforward to apply, thus providing a powerful tool for the search of exotic phases. Applications to a lattice electron model with interactions leading to s and d-wave instabilities are discussed. We finally apply the method to 2D graphene with long range interactions.

37 – Ferroelectricity induced coupling between light and THz acoustic phonons in $BaTiO_3/SrTiO_3$ superlattices

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We report a high resolution ultraviolet Raman investigation of folded acoustic (FA) vibrations in epitaxially grown ferroelectric $BaTiO_3/SrTiO_3$ superlattices. Back and forward scattering spectra evidence the large acoustic stop-band in these phonon mirrors. The FA doublets display an anomalous temperature dependence dissapearing above the ferroelectric transition, which is tuned by $\sim$500 K by varying the thickness of the $BaTiO_3$ and $SrTiO_3$ layers. A mechanism involving the modulation by the acoustic phonons of the spatially periodic ferroelectric polarization explains the observed temperature dependence. The deduced spatial distribution of the polarization is compatible with a multidomain ferroelectric state. These results demonstrate the strong coupling between sound, charge and light in these multifunctional nanoscale ferroelectrics [1].

[1] A. Bruchaussen *et al*, Phys. Rev. Letters, in production.

38 – Giant magnetoresistance and exchange-bias in oxide-based metallic multilayers

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In the last years there has been much research in the area of materials for spintronics applications. Due to the wide variety of oxides available with different electric and magnetic properties, one approach to the problem is to develop heterostructures fully composed of oxides. These materials can be combined to form multilayers with good quality interfaces, allowing the fabrication of multifunctional systems. Our group has been recently involved in the fabrication and study of $La_{0.75}Sr_{0.25}MnO_3$ (LSMO) / $LaNiO_3$ (LNO) multilayers, being LSMO a ferromagnetic manganite and LNO a Pauli paramagnet, both materials presenting a metallic behavior below room temperature. In this talk, an overview of the magnetic and electric properties of films, trilayers and superlattices composed of these materials will be presented. Besides from a giant magnetoresistance effect measured at low temperature, we have observed an unexpected exchange-bias-like behavior.

39 – Nanostructured oxides: synthesis and applications

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Single oxides (tin, silicon, titanium, etc.) and mixed oxides (manganites, cobaltites, etc.) were obtained as free nanoparticles or assembled nanoparticles in hollow (tubes) or solid (wires) nanostructures using a microwave radiation assisted method. The nanostructures were obtained by wetting porous policarbonate films with proper liquid precursors and a two stage thermal process (microwave irradiation and conventional thermal treatments). We characterized the obtained material through Xray diffraction analysis, electron scanning and atomic force microscopies and magnetic measurements. We have shown the feasibility of depositing these nanostructures on top of solid substrates to use them as device components. We are exploring their possible application as catalytic materials in gas sensors and cathodes of solid state fuel cells (SOFC). The magnetic behaviour of nanostructurated manganites was intensively studied.

40 – Instantons and magnetization tunneling: beyond the giant spin approximation

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In this work we show that commonly neglected fluctuations of the net total spin of a molecular nanomagnet strongly modified its tunnelling properties and provide a scenario to explain some discrepancies between theory and experiment. Starting off with an effective spin Hamiltonian, we study the quantum tunneling of the magnetization of molecular nanomagnets in the regime where the giant spin approximation is breaking down. This study is done using an instanton description of the tunneling path. The instanton is calculated considering its coupling to quantum fluctuations in a self-consistent approach. We compare our results with calculations performed through exact diagonalization of the effective spin Hamiltonian and with experimental data.

41 – Current-conserving nonlinear response theory in driven systems

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Using two-particle effective action (2PI-EA) techniques, we study the response of an open interacting electronic system to time-dependent external electromagnetic fields. We show that the 2PI-EA is invariant under a simultaneous gauge transformation of the external field and the full closed-time path (Schwinger-Keldysh) propagator, and that this property holds even when the loop expansion of the 2PI-EA is truncated at arbitrary order. The effective action approach provides a systematic way of calculating the propagator and response functions of the system. Due to the invariance of the 2PI-EA under external gauge transformations, the response functions calculated from it are such that the Ward-Takahashi hierarchy, that ensures current conservation beyond the expectation value level, is satisfied. These findings may be useful in the study of interacting electronic pumping devices.

42 – Quantum Fluctuations and Pairing in Fermi Systems: A Tractable Crossing-symmetric Approach

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Our study is motivated by observations of pairing phenomena, with possibly unconventional pairing symmetries, in several novel systems such as the Fe-As superconductors, ultracold atoms, ferromagnetic superconductors, etc. We consider a tractable version of the diagrammatic crossing-symmetric approach that attempts to obtain competing quantum fluctuations, such as, density, current, spin, spin-current, and higher-order fluctuations in a self-consistent manner. These are then used to carry out a general study of pairing with different pairing symmetries, s, p, and d -wave in Fermi systems with finite-range, non-local interactions of arbitrary strength; the sign of the non-local interaction plays a role in determining which quantum fluctuations are enhanced, and consequently the nature of pairing. We also find that these fluctuations act to suppress the pairing transition temperature; the suppression is robust over a wide range of interaction strength and density.

43 – Transport and thermoelectric properties of multi-phase LSCuO samples grown by citrate sol-gel method

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We have studied the thermoelectric properties of $La_{2-x}Sr_xCuO_{4-\delta}/La_2CuO_4$ ($x = 0.05$, 0.10 *and* 0.15) grown by using the citrate sol-gel method followed by high temperature sintering. Transport properties were studied from electrical resistivity $\rho(T)$ and Seebeck coefficient $S(T)$ measurements, in the temperature range between 100 and 290K. The magnitude of Seebeck coefficient $S(T)$ and electrical resistivity $\rho(T)$ decreases with the Sr content, from $200\mu V/K$ to $25\mu V/K$ and from $20m\Omega - cm$ to $3m\Omega - cm$, respectively. The temperature behavior of $S(T)$ and $\rho(T)$ was interpreted in terms of small-polaron hopping mechanism. From $S(T)$ and $\rho(T)$ data it was possible to calculate the thermoelectric power factor PF, which reaches maximum values close to $6\mu W/K^2 - cm$; the structural and morphological properties of the samples were studied by powder x-ray diffraction analysis (XRD) and scanning microscopy (SEM), respectively. Which show that both phases, the tetragonal metallic $La_{2-x}Sr_xCuO_{4-\delta}$ and orthorhombic semiconducting La_2CuO_4 are present in the samples.

44 – Modulating the spin polarization in multichannel semiconductor rings with Rashba spin orbit coupling

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We investigate the spin accumulation effect in eccentric semiconductor multichannel rings with Rashba spin-orbit interaction and threaded by a finite magnetic flux. Due to the finite eccentricity, the spin polarization induced at the borders of the sample is anisotropic along the azimuthal direction, exhibiting different patterns and intensities at specific angles. This effect, which results reminiscent to the drift of the spin polarization induced by the application of an in plane electric field, could be used to manipulate and functionalize the spin polarization in electronic nanorings.

45 – Statistical model for the formation of the $Ge_{1-x}Sn_x$ alloy

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Important technological applications in nano- and optoelectronics are envisaged for low-energy direct energy-gap compounds, tunable by doping or strain. Furthermore, if based on group IV elements as $Ge_{1-x}Sn_x$ alloys, they provide ideal candidates for devices with a high compatibility with Si-based integrated circuits. Examples of predicted applications are for: infrared lasers, long-wavelenght photodetectors and emitters, nanostructured thermoelectric cooling devices for achieving higher speed in Si microelectronics, etc.

Binary alloys of group IV semiconductors are usually easy to prepare at any concentration, but this is not the case for the $\mathrm{Ge}_{1-x}\mathrm{Sn}_x$ alloy. Homogeneous alloys, as required for device applications, have proved difficult to form for x above a temperature-dependent critical concentration, above which Sn exhibits the tendency to segregate in the metallic cubic β phase, spoiling the semiconducting properties. The underlying mechanism for this segregation and critical concentration was not known.

Through previous accurate *ab-initio* local defect calculations we estimated the scale of energies involved in the immediate environment around a large number of different Sn defects in Ge, the relaxed configurations of the defects, and the pressure directly related to the elastic field caused by the defects. This detailed information allowed us to build a simple statistical model including the defects most relevant at low x, namely substitutional $\alpha - Sn$ and non-substitutional $beta - Sn$ (in which a single atom occupies the center of a Ge divacancy). Our model enables us to determine at which concentration the β defects, which exhibit a tendency to segregate, can be formed in thermal equilibrium. These results coincide remarkably well with experimental findings, concerning the critical concentration above which the homogeneous alloys cannot be formed at room temperature. Our model also predicts the observed fact that at lower temperature the critical concentration increases.