2010 年复旦物理系学术年会

报告摘要集

复旦大学物理系

2010 年 6 月 5 日

内容

会议简介

年会时间

2010 年 6 月 5 日（周六）

参加对象

物理系硕、博研究生、教师。

会议目的

以学术促交流，以交流促学术。

学术委员会

召集人：沈健
委员：全体发展委员会成员

年会筹备委员会

召集人：周磊
委员：陈骏逸、蔡越华、刘凡美、俞熹、刘范美

年会召开期间的全体工作人员

蔡越华、陈骏逸、刘凡美、余熹、刘范美

会议计划

邀请报告　15 个，
海报　148 个

2010 年复旦物理系学术年会日程安排

2010 年 6 月 5 日，周六 (地点：光华东辅楼 400 人会议室)

8:00-8:25	注册	
8:25-8:30	开幕式（发言人：沈健）	
邀请报告（教师）	**（主席：游建强）**	
8:30-9:00	车静光	金属/graphene 界面输运性质的第一性原理研究
9:00-9:30	沈健	Observation of doping effect at the surfaces of manganites using scanning tunneling microscopy
9:30-9:50	肖江	Theory of magnon-driven spin Seebeck effect
邀请报告（学生）	**（主席：张新夷）**	
9:50 - 10:05	叶力 （金晓峰课题组）	Unraveling the Intrinsic and Extrinsic Mechanisms of Anomalous Hall Effect in Nickel
10:05 - 10:20	杨乐仙 （封东来课题组）	Coexistence of band splitting characterized SDW and superconductivity in 122 series of iron-based materials
10:20 -10:35	董金奎 （李世燕课题组）	Quantum Criticality and Nodal Superconductivity in the FeAs-Based Superconductor KFe_2As_2
10: 35-13:30　茶歇、海报（上午场）、 午餐 **12: 00 拍集体照（地点：光华楼正门）**		
邀请报告（教师）	**（主席： 钟振扬）**	
13:30-14:00	吴义政	Quantum oscillation of magnetic anisotropy in Fe ultrathin film
14:00-14:30	陈张海	Quantum chaos of anisotropic hydrogen-like atom in magnetic fields
14:30-14:50	向红军	First-principles study on some multiferroics
邀请报告（学生）	**（主席： 周仕明）**	
14:50-15:05	施小峰 （游建强课题组）	Quantum phase transitions in Kitaev spin models
15:05-15:20	郭志新 （龚新高课题组）	Thermal conductivity of low-dimensional nanosystems
15:20-15:35	孙正义 （侯晓远课题组）	The role of LiF buffer layer in the OLED with Au cathode
15:35-19:30 茶歇、海报（下午场） **18:00-19:00 晚餐（旦苑餐厅 3 楼）**		

邀请报告（教师）		（主席：周鲁卫）
19:30-19:50	陈唯	Short-time self-diffusion of weakly charged colloidal spheres at aqueous interface
19:50-20:10	肖艳红	Recent progress in our lab
20:10-20:40	黄吉平	Optical negative refraction in colloidal ferrofluids
20:40 – 21:00 颁奖+年会闭幕（主持：蒋最敏）		

会议目录

Invited Speaker

Poster session

报告摘要

金属/graphene 界面输运性质的第一性原理研究

车静光

实验发现，Pd 和 Pt 与纳米碳管之间的电导存在巨大差异，Pd 具有几乎弹道输运极限（即意味着没有势垒）电导，这个工作解决了电子时代（真空管）以来的一大难题，对未来器件的重要性不可估量。但同时，这个工作也提出了一个令人迷惑的问题：其他金属甚至是 Pd 的同族元素 Pt 为什么不能实现这种接触？我们发现并命名的 exchange-transfer 机制是解释该问题的关键：这个机制最重要的特点是，由于 Pd-graphene 的相互作用，graphene 的 π 轨道上的电子向 Pd 的 dxz+yz 转移，损失的电子又从 Pd 的 dz2 轨道上的电子得到补偿。因此，该机制在增加相互作用从而增加 Pd-graphene 之间电导通道的同时，又补偿了 graphene 赖以导电的 π 电子，所以导电性好。与 Pd 同构的 Pt 由于较强的 Pt-Pt 自相互作用而无法激发这个机制。对其他金属，虽然典型的 Ti 金属与 graphene 相互作用更强，graphene 上的 π 电子与 Ti 形成很强的共价键，但 graphene 由此缺少了很多赖以导电的 π 电子，而增加的相互作用又主要以共价键形式出现，两者对 Ti/graphene 之间的输运都是不利的。

Observation of doping effect at the surfaces of manganites using scanning tunneling microscopy

沈健

Abstract

Perovskite manganites belong to a class of material in which charge, spin, orbital and lattices degrees of freedom are strongly coupled. While the corresponding parent compound is often non-ferromagnetic and insulating, upon doping manganites exhibit striking behavior such as colossal magnetoresistance, charge and orbital ordering , and electric field driven resistivity switching. Surfaces offer an ideal platform to study the doping effect including the spatial distribution of doped holes and their correlation with long-range electronic ordering. Moreover, the broken symmetry at surfaces provide an interesting way to intrinsically dope the system, which can have dramatic effect on magnetic and transport properties of the manganites. Using atomically resolved scanning tunneling microscopy, we were able to obtain a real space view of these phenomena at atomic scale.

Theory of magnon-driven spin Seebeck effect

肖江

Abstract

We propose an mechanism for the recently discovered spin Seebeck effect in terms of a spin pumping-current driven through a ferromagnet/normal metal interface by a difference between the magnon temperature in the ferromagnet and the electron temperature in the normal metal. This spin current is proportional to this temperature difference, which is excited by an applied heat current through the ferromagnet, the spin-mixing conductance of the interface, and the inverse of a temperature-dependent magnetic coherence volume, and can generate an inverse spin Hall voltage(spin Seebeck signal) in a normal metal contact attached to the ferromagnet.

Unraveling the Intrinsic and Extrinsic Mechanisms of Anomalous Hall Effect in Nickel

Li Ye*, Yuan Tian and Xiaofeng Jin
Surface Physics Laboratory and Physics Department,
Fudan University, Shanghai, China

Anomalous Hall effect (AHE) has long been a puzzled issue in condensed matter physics due to its diverse experimental manifestation, delicate intrinsic nature determined by band structure, and entangled intrinsic and extrinsic contributions [1-4]. By exploring AHE in nanometer thick Ni film, we succeed to identify the prevailing intrinsic contribution from 5 to 330K in terms of Hall conductivity. The obtained intrinsic Hall conductivity appears strongly temperature dependent, which explains the known significant divergence between first principle calculation and experimental result [5]. We also obtained minor elastic skew scattering and negligible side jump terms. Our strategy to identify underlying mechanisms and their temperature dependence provides a new experimental approach to gain better insight of spin related Hall effect and pave the way to better artificial design of spintronic device at room temperature.
This work was supported by MSTC (No. 2006CB921303 and No.2009CB929203) and NSFC (No. 10834001).
[1] The Hall Effect and Its Applications, edited by C. L. Chien and C. R. Westgate (Plenum, New York, 1980)
[2] Takahashi, S. et al., Concepts in Spin Electronics (ed. S. Maekawa, Oxford Univ. Press, Oxford, 2006).
[3] N. Nagaosa et al., arXiv: 0904.4154
[4] N. A. Sinitsyn, J. Phys. Condens. Matter 20, 023201 (2008).
[5] X. J. Wang et al., Phys. Rev. B 76, 195109 (2007)

Coexistence of band splitting characterized SDW and superconductivity in 122 series of iron-based materials

杨乐仙

The nature of the spin-density wave (SDW) and its relation with superconductivity are crucial in the newly discovered iron-based materials. Here we present the direct measurements on the electronic structure of parent and superconducting compounds, $BaFe_2As_2$ and $Sr_{1-x}K_xFe_2As_2$. We show that the energy of the SDW in $BaFe_2As_2$ is mainly lowered through exotic exchange splitting of the band structure. This band splitting is also observed in both parent and superconducting $Sr_{1-x}K_xFe_2As_2$ systems, which proves that the SDW and superconductivity could coexist in iron based superconductors.

Quantum Criticality and Nodal Superconductivity in the FeAs-Based Superconductor KFe_2As_2

J. K. Dong,[1] S.Y. Zhou,[1] T.Y. Guan,[1] H. Zhang,[1] Y. F. Dai,[1] X. Qiu,[1] S.Y. Li[1*] and X. F. Wang,[2] Y. He,[2] X. H. Chen,[2]

[1]*Department of Physics, Surface Physics Laboratory (National Key Laboratory), Laboratory of Advanced Materials, Fudan University, Shanghai 200433, People's Republic of China*
[2]*Hefei National Laboratory for Physical Science at Microscale and Department of Physics, University of Science and Technology of China, Hefei, Anhui 230026, China*

The in-plane resistivity ρ and thermal conductivity κ of the FeAs-based superconductor KFe_2As_2 single crystal were measured down to 50 mK. We observe non-Fermi-liquid behavior $\rho(T) \sim T^{1.5}$ at $Hc_2 = 5T$, and the development of a Fermi liquid state with $\rho(T) \sim T^2$ when further increasing the field. This suggests a field-induced quantum critical point, occurring at the superconducting upper critical field Hc_2. In zero field, there is a large residual linear term κ_0/T, and the field dependence of κ_0/T mimics that in d-wave cuprate superconductors. This indicates that the superconducting gaps in KFe_2As_2 have nodes, likely d-wave symmetry. Such a nodal superconductivity is attributed to the antiferromagnetic spin fluctuations near the quantum critical point.

Quantum oscillation of magnetic anisotropy in Fe ultrathin film

Y. Z. Wu

The electrons in the nanometer scale thin films could be confined to form quantum well states (QWS), and many novel thickness-dependent oscillation of physical properties induced by QWS in non-magnetic films were discovered. Modern magnetoeletronics devices are based on metallic films with thicknesses on the nanometer scale, so it would be very important to experimentally explore how the QWS in ferromagnetic films affect the intrinsic magnetic properties in magnetic nanostructure research.

In this talk, we will report the study on thickness- and temperature-dependent step-induced in-plane magnetic anisotropy of Fe films grown on vicinal Ag(1,1,10) surface utilizing magneto-optic Kerr effect. At low temperatures, below 200 K, the magnetic in-plane uniaxial anisotropy strongly oscillates as a function of Fe thickness with the period of 5.7 monolayers(ML). For the sample covered with Au, also the easy magnetization axis oscillates between perpendicular and parallel to the steps with the same period. Our results also indicate the out-of-plane magnetic anisotropy of Fe films oscillates with the Fe thickness. Such oscillation of magnetic anisotropy is attributed to the quantum well states(QWS) of the *d*-band electrons in Ferromagnetic Fe films, and this QWS was directly observed in Fe/Ag(001) system by the angular-resolved photoemission spectroscopy(ARPES). The lack of oscillation at RT may result from the thermal reduction of the electron mean free path.

Quantum chaos of anisotropic hydrogen-like atom in magnetic fields

陈张海

First-principles study on some multiferroics

Hongjun Xiang

Multiferroic materials with their coexisting ordered states of electric and magnetic dipoles may find use in many technological applications such as magnetoelectric random-access memory by virtue of their low power consumption. In this talk, I will present some of our results on novel ferroelectrics due to charge ordering and magnetic ordering. Our full relativistic density functional calculations show that the ferroelectricity in the spiral magnets is due to spin-orbit interactions. And our work indicates that the pure electronic KNB model is inadequate to determine the magnitude and the absolute direction of FE polarization in spin-spiral states. In contrast, it is crucial to consider the displacements of the ions from their centrosymmetric positions.

Quantum phase transitions in Kitaev spin models

施小锋

We study the quantum phase transitions in the Kitaev spin models on both honeycomb and Fisher (triangle-honeycomb) lattices. Our analytical results show that the Kitaev spin model on the honeycomb lattice exhibits a continuous quantum phase transition. We also reveal the relationship between bipartite entanglement and the ground-state energy. Our approach directly shows that both the entanglement and the ground-state energy can be used to characterize the topological quantum phase transition in the Kitaev spin model on the honeycomb lattice. Also, we show that the quantum phase transitions can occur in the same topological class for the Kitaev spin model on the Fisher lattice.

Thermal conductivity of low-dimensional nanosystems

郭志新

By employing molecular dynamics method, we studied the thermal conductivity of several low-dimensional nanosystems. Firstly, we studied the influence of various simulation-technique factors on the thermal conductivity of single-walled carbon nanotubes (SWCNs). We demonstrated that the thermal conductivity values are not profoundly influenced by the specific simulation-technique used in the molecular dynamics simulations. The possible reason was further proposed to be responsible for the discrepancies in the literatures.

Then we investigated thermal conductivity of graphene nanoribbons (GNRs) with different edge shapes as a function of the length, width, and strain. It was found that the GNRs have very high thermal conductivities and long phonon mean free paths (PMFPs). Moreover, the thermal conductivity is very sensitive to the edge shapes. The zigzag GNRs' thermal conductivity increase first and then decrease with the width increasing, while, the armchair GNRs' thermal conductivity monotonously increase with width. Remarkable decrease of thermal conductivity is also obtained when a tensile/compressive uniaxial strain is applied on the GNRs.

Finally, we proposed a new approach to manipulate the thermal conductivity of the nanomaterials based on a coupled atom-chain model. By coupling to different substrates, the thermal conductivity can be either remarkably decreased or increased, which can be realized in the applications. Through the illustrations of double-walled carbon nanotubes and ice nanotubes, it was further shown that our approach is applicable in the real systems. Compared with the conventional treatments, our approach can truly realize the thermal conductivity manipulation in solid nanomaterials and barely destroy otherwise physical properties of nanomaterials, which opens a new door for advancing the performance of nanoelectronic and thermoelectric devices.

The role of LiF buffer layer in the OLED with Au cathode

孙正义

Abstract

As known, Au is not suitable as cathode of Organic Light-emitting Device (OLED) because of the high work function and the resulting poor electron injection. In our experiment, we find LiF buffer layer can also efficiently improve the performance of Au-cathode OLED and in the optimal case even achieve a comparable luminescence with conventional Al-cathode device. The relationship between the thickness of LiF layer and the performance improvement is obtained, which is discussed by tunneling model.

Short-time self-diffusion of weakly charged colloidal spheres at aqueous interface

陈唯

摘要:

Optical microscopy and multi-particle tracking are used to study the short-time self diffusion of weakly charged colloidal spheres at a aqueous interface. The measured short-time self diffusion coefficient D_{SS} has the form, $D_{SS}/D_0 = \alpha(1-\beta n)$, where n is the area fraction occupied by the particles and D_0 is the Stokes-Einstein diffusion coefficient of individual particles in the bulk fluid. The obtained values of α and β differ from those obtained for bulk suspensions, indicating that hydrodynamic interactions between the interfacial particles have interesting new features when compared with their three-dimensional counterpart.

Recent progress in our lab

肖艳红

摘要

In this talk, I will first describe current reseach projects in our lab, then I will report the progress towards a novel Frequency Modulation laser spectroscopy, which allows power broadening free measurement of a resonance. Preliminary experiment results will be presented. Such a narrow resonance technique can be employed in precision metrology such as atomic magnetometery and clocks, and is also relevant to squeezed state of light.

Optical negative refraction in colloidal ferrofluids

黄吉平

摘要

Ferrofluids are suspensions of ferromagnetic or ferrimagnetic nanoparticles suspended in a carrier liquid. We numerically demonstrate optical negative refraction in ferrofluids containing isotropic Fe3O4 nanoparticles, each having an isotropic Ag shell, in the presence of an external dc magnetic field H. As a result, we have proposed a class of soft optical metamaterials. The all-angle broadband optical negative refraction with magnetocontrollability arises from H-induced chains or columns. They result in hyperbolic equifrequency contour for transverse magnetic waves propagating in the system. The finite element simulations verify the analyses using the effective medium approximation. Experimental demonstration and potential applications are suggested and discussed.

Fe/GaAs(001)体系的单轴磁各向异性

陈宫 朱捷 栗佳 刘方泽 肖夏 吴义政
复旦大学物理系，应用表面物理国家实验室, 先进材料实验室 上海 200433

在半导体衬底上生长铁磁金属薄膜由于在自旋电子学器件中潜在的应用价值而一直受到人们极大的重视[i]。Fe/GaAs体系的优点在于：Fe具有较高的居里温度、较大的自旋极化率和两者之间较小的晶格失配(-1.4%)。研究表明，较薄的Fe薄膜外延在GaAs(001)上会产生一个易轴沿着[110]的单轴磁各向异性，但这个磁各向异性的物理机制还不是很清楚，一般认为来源于Fe/GaAs(001)的界面磁各向异性[ii]。Thomas等人[iii]发现很厚的Fe薄膜的单轴磁各向易轴会转到[1-10]，这个结果无疑和单轴磁各向异性来源于界面是相矛盾的，他们用观察到的面内晶格弛豫各向异性产生的磁弹能来解释这个转向。对于一个铁磁薄膜，磁各向异性可以用体的贡献 K_v 和界面的贡献 K_s 描述成： $K = K_v + K_s / d$ ，但是 K_v 是否对Fe薄膜的单轴磁各向异性转向有贡献仍不清楚。

为了更好地理解这个问题我们系统地研究了Fe/GaAs(001)体系的各向异性，利用MOKE和旋转磁场MOKE技术（图1）定量地测量了Fe薄膜磁各向异性随Fe薄膜厚度的变化关系。我们发现Fe的单轴磁各向异性和厚度呈$1/d_{Fe}$的变化关系 （图2），在d_{Fe}~35ML时易轴从[110]转到[1-10]，同时正的 K_v 和负的 K_s 说明单轴磁各向异性易轴的转向来源于单轴各向异性体贡献和界面贡献的竞争。改变Fe薄膜的生长温度表明：50-70°C时界面贡献和体贡献均较大，而生长温度的升高或降低都会使之减小。将Fe薄膜生长在GaAs(001)的台阶表面，界面贡献和体贡献在[110]台阶方向同时被增强，在[1-10]台阶方向却被抑制。此外我们发现单轴磁各向异性的体贡献和界面贡献呈大致线性的关系。综上我们推断体贡献的产生有可能和GaAs(001)表面再构有关，通过氩刻破坏GaAs(001)表面的再构确实可以抑制体的贡献。

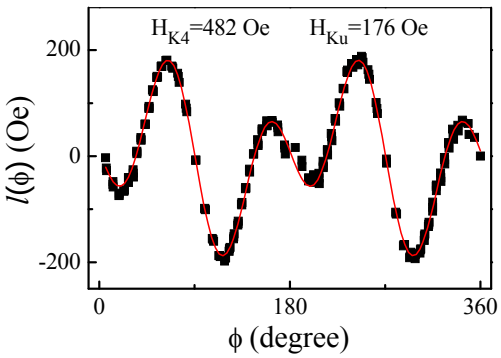

图 1. 105ML Fe的Rot-MOKE数据

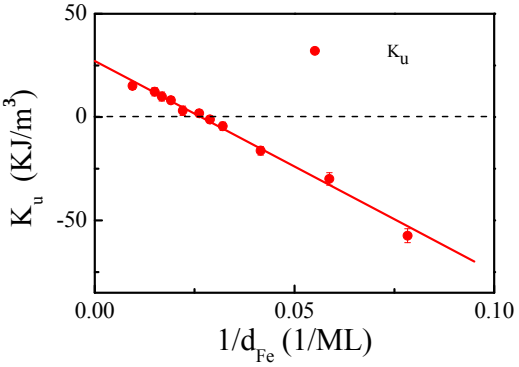

图 2. 单轴磁各向异性随 $1/d_{Fe}$ 的变化

Rashba splitting of graphene on Ni, Au, or Ag(111) substrates

Z. Y. Li, S. Qiao and Z. Q. Yang

State Key Laboratory of Surface Physics and Department of Physics, Fudan University, Shanghai 200433, China

We report first-principles investigations on Rashba splitting of π-band in graphene grown on Ni, Au, or Ag(111) substrates. The graphene on the all three kinds of metals is found to show Rashba splitting in the order of several or several tens of meV. The splitting is the strongest in Au case and the weakest in Ni. The effect is rationalized by the asymmetrical potential distributions at the two sides of graphene induced by the substrates and the hybridization of π electrons of graphene with the d electrons of metals. The Rashba splitting is not found to relate closely to the charge transfer between the graphene and the substrates.

Conjugates of folic acids with BSA coated quantum dots for cancer cell targeting and imaging by single-photon and two-photon excitations

He Meng, Ji-Yao Chen, Lan Mi, Pei-Nan Wang, Mei-Ying Ge, Yang Yu, Ning Dai

The BSA coated CdTe/ZnS quantum dots (BSA-QDs) were selected to conjugate with folic acid (FA) forming FA-BSA-QDs. This study aims to develop these small size FA-BSA-QDs (< 10 nm) for the diagnosis of cancers in which the FA receptor (FR) is overexpressed. The enhancement of cellular uptake in FR positive human nasopharyngeal carcinoma cells (KB cells) for FA-BSA-QDs was found by means of confocal fluorescence microscopy with single-photon and two-photon excitations. The enhancement for FA-BSA-QDs was further evaluated as about 3 times higher averagely as compared to BSA-QDs, measured by flow cytometric analysis in 10^4 KB cells. Such uptake enhancement for FA-BSA-QDs was suppressed when KB cells had been pretreated with excess FA, reflecting that the enhancement was mediated by the association of FR in cell membranes with FA-BSA-QDs. When human embryonic kidney cells (293T) (FR negative cells) and KB cells were incubated with FA-BSA-QDs (1μM) for 40 minutes, respectively, the FA-BSA-QD uptake of 293T cells was much weak as compared with that of KB cells, demonstrating that FA-BSA-QDs can take a preferential binding on FR positive cancer cells. These characteristics suggest that FA-BSA-QDs are potential candidates for cancer diagnosis, and worth investigating further.

Single-Crystalline Hexagonal ZnO Microtube Optical Resonators

Hongxing Dong,1 Zhanghai Chen,1 Liaoxin Sun,1 Wei Xie,1 H. Hoe Tan,2 Jian Lu, Chennupati Jagadish,2 and Xuechu Shen1

We report the synthesis and the optical properties of free-standing, high quality ZnO microtubes with hexagonal cross sections that can be used as optical resonators. These microtubes were directly formed through a simple oxidation–sublimation process. Compared with the methods mentioned earlier, our approach does not require catalysts, templates, carrier gases, or low pressure. WGMs, Fabry-Pérot modes (FPMs) and wave-guided modes with different polarization (TE, E⊥c-axis and TM, E∥c-axis) were directly observed in the visible spectral range at room temperature, and the modulation was mapped directly by using the spatially resolved spectroscopic technique. The resonator properties in relation to the tube cavity diameter and wall thickness were studied in detail. Calculations based on the plane wave interference model and Cauchy dispersion functions agree well with the experimental data. The experiments and theoretical analyses indicate that the ZnO hexagonal microtube resonator is a promising test-bed for investigating new optical modulation behavior and developing novel optical devices.

Annealing effect of low temperature grown Si capping layers on SiGe quantum dots

Jian Cui, Jianhui Lin, Yueqin Wu, Yongliang Fan, Xinju Yang, and Zuimin Jiang
State Key Laboratory of Surface Physics, Fudan University, Shanghai 200433, China

In microelectronic and nanoelectronic quantum devices, the device performance not only highly correlates with the quantum structures but also the structures of surrounding area. Thus, for the quantum dots (QDs), the growth of capping layers on QDs is important to passivate the surface. However, the capping process at high temperatures will change the morphology dramatically to quantum rings. [1, 2] When the Si capping layer is grown at low temperatures, though the morphology of QDs which are buried in the capping layer is preserved, however planar defects are observed in a thick Si capping layer and over the QDs. [3] In this paper, the annealing effect of low temperature grown Si capping layer on SiGe QDs is investigated, in order to explore a process by which the morphology of QDs is preserved in the Si capping layer and at the same time the defects in the low temperature grown Si layer could be eliminated.

The Si capping layer with a thickness of 50 nm was deposited at a temperature of 300 ^{o}C. The surface morphology of Si capping layer is similar to that of as grown SiGe QDs, as shown in Figs. 1(a) and 1(b). After annealing at 640 ^{o}C for 10 min, the dot structures evolved to pits with a depth of about 8 nm and the boundaries along <110>, as shown in Fig. 1(c). Transmission electron microscopy (TEM) observation shows that the dots and pits have one to one correspondence, as shown in Fig. 1(d). By in situ annealing at a lower temperature of 540 ^{o}C, the detailed migration of Si atoms during the pit formation is revealed. The mechanism for the pit formation is proposed based on strain energy relief and minimization of surface energy.

The obtained pit patterns could be used as templates for the growth of quantum dot molecules. The deposition of Ge atoms on a pit patterned surface will result in the formation of QD molecules surrounding the pits, as shown in Fig. 2, with a 90^{o} rotation of the pit boundaries. The mechanism for the QD molecules formation is discussed.

[1] J. M. Garcia, et al., **Appl. Phys. Lett. 71** 2014 (1997).
[2] J. Cui, et al., **Appl. Phys. Lett. 83** 2079 (2003).
[3] J. H. Lin, et al. **J. Appl. Phys. 105** 024307 (2009).

Multigap nodeless superconductivity in FeSe*x*: Evidence from quasiparticle heat transport

T. Y. Guan,[1] J. K. Dong,[1] S. Y. Zhou,[1] X. Qiu,[1] L. Ding,[1] C. Zhang,[1] U. Patel,[2] Z. L. Xiao,[2] and S. Y. Li[1],*

[1]*Department of Physics, Surface Physics Laboratory (National Key Laboratory), and Laboratory of Advanced Materials, Fudan University, Shanghai 200433, People's Republic of China*

[2]*Department of Physics, Northern Illinois University, DeKalb, Illinois 60115, USA*

The in-plane thermal conductivity κ of the iron selenide superconductor FeSe*x* (*Tc*=8.8 K) was measured down to 120 mK and up to 14.5 T (≈3/4*Hc*2). In zero field, the residual linear term κ_0/T at $T\rightarrow 0$ is only about 16 μW K^{-2} cm^{-1}, less than 4% of its normal-state value. Such a small κ_0/T does not support the existence of nodes in the superconducting gap. More importantly, the field dependence ofκ_0/T in FeSe*x* is very similar to that in NbSe2, a typical multigap *s*-wave superconductor. We consider our data as strong evidence for multigap nodeless (at least in *ab* plane) superconductivity in FeSe*x*. This kind of superconducting gap structure may be generic for all Fe-based superconductors.

Quantum Chaotic Dynamics of Electron in Solid State Environment

陈张海

We report the first experimental study on the quantum chaotic dynamics of hydrogen analogues in solid state environment. We realized the hydrogen analogue in anisotropic crystal field by introducing an isolated phosphorus donor in Si and study its quantum chaotic dynamics by means of photo-thermal ionization spectroscopy technique. The interference of electron wave packets which leads to quasi-Landau resonances were observed. By analyzing the magnetic field dependence of the statistical energy level distributions, we observed smooth transitions between the Poisson limit and the Wigner limit for the impurity energy level distributions, demonstrating the magnetic field control of the quantum chaotic dynamics of hydrogen analogues in an anisotropic crystal field. Effects of the crystal field anisotropy on the quantum chaotic dynamics have been studied and good agreements between theoretical calculations and the experimental data were found.

Analytical partial wave expansion of vector Bessel beam and its application to optical binding

Jun Chen, Jack Ng, Pei Wang, and Zhifang Lin
Surface physics Laboratory, Department of Physics, Fudan University, Shanghai, China

Based on the angular spectrum representation, explicit partial wave coefficients are given for nondiffractive vector Bessel beam of arbitrary order and polarization. Calculations based on the analytical partial wave expansion yield results that agree well with recent numerical calculations and experiments on optical binding. We have also investigated how one can tailor the interparticle interaction by overlaying different coatings. It is found that the Ag and low dielectric coating can increase the number of equilibrium positions, whereas the antireflection coating reduces it.

Optical Negative Refraction in Ferrofluids with Magnetocontrollability

Y. Gao and J. P. Huang

Department of Physics, Fudan University, Shanghai 200433, China

Ferrofluids are colloidal suspensions composed of ferromagnetic or ferrimagnetic nanoparticles of about 10 nm diameter dispersed in a carrier fluid, usually water or kerosene. We numerically demonstrate optical negative refraction in ferrofluids containing isotropic Fe_3O_4 nanoparticles, each having an isotropic Ag shell, in the presence of an external dc magnetic field H. The all-angle broad-band optical negative refraction with magnetocontrollability arises from H-induced chains or columns. They result in hyperbolic equifrequency contour for transverse magnetic waves propagating in the system. The finite element simulations verify the analyses using the effective medium approximation. Experimental demonstration and potential applications are suggested and discussed.

Dynamical Green's function theory to study the optical phenomena related to metamaterials

Weihua Wang, Xueqin Huang, and Lei Zhou*

Surface Physics Laboratory (State Key Laboratory) and Physics Department, Fudan University, Shanghai 200433, P. R. China

Abstract

We combine a space-time Lorentz transformation with a dyadic Green's function technique to establish a general and rigorous dynamical theory, which can be employed to study the optical phenomena occurring in a moving environment. As the applications of this method, we studied the Doppler effects of a source moving near a metamaterial slab and the super imaging effect achieved by a moving metamaterial lens. Many interesting anomalous phenomena were discovered, induced typically by the interplays between the source and the surface waves of the metamaterial slab.

Poster : 071019017@fudan.edu.cn

Reference :

(1) *Weihua Wang*, Xueqin Huang, Lei Zhou, "Doppler effects of a light source on a metamaterial slab: a rigorous Green's function approach", Photonics and Nanostructures - Fundamentals and Applications 8, 23 (2010).

(2) *Weihua Wang*, Xueqin Huang, Lei Zhou, and C. T. Chan, "Doppler effects of a light source on a metamaterial slab: a rigorous Green's function approach", Opt. Lett. 33, 369 (2008).

Single crystalline Tm_2O_3 film grown on Si (001) by atomic oxygen assisted molecular beam epitaxy

T. Ji[1], J. Cui[1], Y. L. Fan[1], Z. B. Fang[2], and Z. M. Jiang[1]*
[1]State Key Laboratory of Surface Physics, Fudan University, Shanghai 200433, China
[2] Department of Physics, Shaoxing University, Shaoxing 31200, China

Single crystalline Tm_2O_3 film has been grown on Si (001) substrate successfully by molecular bean epitaxy using metallic Tm and atomic oxygen source. The temperature of the Tm source was kept at 700℃ during film growth and the partial pressure of oxygen in the chamber was 2×10^{-7} Torr. The samples were characterized by *in-situ* high energy electron diffraction (RHEED), Auger electron spectroscope (AES), *ex-situ* synchrotron X-ray diffraction (XRD, Shanghai synchrotron radiation facility BL14B) and atomic force microscope (AFM).

The single crystalline Tm_2O_3 film was achieved by two different growth methods: multi-step growth and single-step growth. The growth procedure for multi-step is as follows:

1. A thin layer (~0.67nm) of Tm_2O_3 film was deposited at a substrate temperature of 600℃ and then the film was annealed at 800℃ in ultra-high vacuum (UHV) till a streaky RHEED pattern was observed. Before annealing, a very thin amorphous SiO_x layer was inevitably formed between Si substrate and Tm_2O_3 film, by comparing AES spectra of oxidized Si signals of clean Si substrate (Fig. 1(a)) and as-deposited Tm_2O_3 film (Fig. 1(b)). The existence of the amorphous SiO_x layer induces the Tm_2O_3 film amorphous, for no RHEED pattern was observed (Fig. 2(b)). After annealing, the interfacial SiO_x layer decomposed and Tm_2O_3 film crystallized. Form AES spectra the signal of oxidized Si disappeared (Fig. 1(c)) and a streaky RHEED pattern appeared (Fig. 2(c)), indicating good crystallinity of the Tm_2O_3 film. This thin Tm_2O_3 layer offers a template for the successive growth.
2. Another 1.33 nm thick Tm_2O_3 was deposited at 600℃ and the film was annealed again at 800 ℃ in UHV to improve the crystallinity. Before annealing the streaky pattern was preserved (Fig. 2(d)). After annealing the stripes of RHEED pattern become clearer than those in step 1 (Fig. 2(e)).
3. 4 nm thick Tm_2O_3 was grown continuously at 600℃.After growth, the film was *in-situ* annealed at 700℃ for 30 min in atomic O ambience. High contrast streaky RHEED pattern was obtained (Fig. 2(f)).

The single crystalline Tm_2O_3 film was also achieved by single-step growth method: the 6 nm Tm_2O_3 film was deposited continuously on the Si substrate, the growth temperature and O partial pressure were the same as those of multi-step growth.

The crystallinity of the films grown by the two methods was the same. The epitaxial relationship between the film and the Si substrate is the same as Er_2O_3, [1] Tm_2O_3 (110)//Si (001), Tm_2O_3 [001]//Si [110] or Tm_2O_3 [-110]//Si [110] as determined by conventional XRD and grazing incidence XRD (GIXRD) shown in Fig. 3. Two domains are visible from the GIXRD spectrum.

There are some differences in their electrical properties, i.e. C-V and I-V curves. By the method of multi-step growth, higher capacitance and thus a higher dielectric constant of 10.8 can be obtained. For the absence of the SiO_{2-x} interfacial layer, the leakage current density is also higher (Fig. 4).

Our results show that crystallinity is the same for the two different growth methods. The multi-step growth procedure has its advantage over the single-step growth in terms of the interface and fixed charge density, while the single-step growth method can get lower leakage current densities.

[1]. R. Xu, Y. Y. Zhu, S. Chen, F. Xue, Y. L. Fan, X. J. Yang, and Z. M. Jiang, J. Cryst. Growth 277, 496 (2005)

Oscillatory magnetic anisotropy originating from quantum well states in Fe films

Jia Li[1] , Marek Przybylski[2], Fikret Yildiz[2], XiaoDong Ma[2], Yizheng Wu[1*]

1. *Surface Physics Laboratory (National Key Laboratory), Department of Physics, Fudan University, Shanghai, China*
2. *Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany*

Abstract

The magnetic anisotropy of Fe film grown on vicinal Ag(1,1,10) surfaces was studied with the in situ magneto-optic Kerr effect. Below 200 K, strong oscillations of the uniaxial magnetic anisotropy as a function of Fe thickness with a period of 5.7 monolayers are found, which can even cause the easy magnetization axis to oscillate between perpendicular and parallel to the steps. Moreover, the magnetization of Fe film was found to tilt away from the surface plane, due to the competition between the crystalline anisotropy and the shape anisotropy. In addition, the perpendicular magnetization component oscillates with the Fe thickness at low temperature, implying the oscillation of the perpendicular anisotropy. Such novel oscillations of the anisotropy are attributed to the quantum well states of d-band electrons at the Fermi level in the Fe film and this quantum well state is observed by Angle-Resolved Photoemission Spectrum.

Determination of the anisotropy field strength in magnetic films using magneto transport measurement

W. N. Cao, J. Li, Y. Z. Wu
Surface Physics Laboratory (National Key Laboratory), Department of Physics, Fudan University, Shanghai, China

Abstract

A usual method to determine the magnetic anisotropy of magnetic thin film is ROTMOKE. This method need to saturate the magnetization in the hysteresis measurement. Anisotropic transport measurement does not necessary to saturate the magnetization. It is much better than the hysteresis technique in the study of the exchange coupling of magnetic multilayer because the magneto transport measurement won't break the F/AF exchange biasing as in a coercivity measurement. Here I demo the setup of transport measurement. The magnetic anisotropy of MgO(3nm)/ Fe (10nm)/MgO(001) film grown epitaxially by MBE was determined by ROTMOKE and Planar Hall Effect. The results from these two methods are same but better signal to noise ratio can be obtained by planar Hall effect. Linear dependence of planar Hall effect on temperature was found from 90K to room temperature.

The nature of herd behavior in resource distribution system

Li Zhao*, Guang Yang*, Wei Wang*, Yu Chen†, and Jiping Huang*‡

* Department of Physics, State Key Laboratory of Surface Physics, and Key Laboratory of Micro and Nano Photonic Structures (Ministry of Education), Fudan University, Shanghai 200433, China;

†Department of Systems Innovation, Graduate School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan

Abstract

The formation of herd can be found in the collective behaviors of many species, including human beings. It pertains to the behaviors of human formed systems, such as stock markets, the world of fashion, violent mobs, etc. In order to study the herd effect on economic systems, here we carry out a set of behavioral economic experiments and build an agent-based model by introducing "imitators" into an extended minority game model called the market-directed resource allocation game. To understand the behavior of people in decision-making, we analyze the preferences of players under different conditions in experiments and calculate the information entropy of agents in the model. Both the experiments and the simulations show that when the market environment is simple (the distribution of resource is nearly uniform), the herd formed by imitating agents may cause large fluctuations. As the environmental complexity is increased (there is a big bias among resource distribution), however, the same imitators can form a helpful herd, improving the efficiency and the stability of the allocating system. Such conclusions are further confirmed by theoretical analysis. This work has general relevance to resource distribution in human life.

Main Reference:

1. Wang, W., Chen, Y. & Huang, J. P. Heterogeneous preferences, decision-making capacity and phase transitions in a complex adaptive system. *PNAS* 106, 8423-8428 (2009).
2. Yu, Y. Y., Xu, C., Gu, G. Q. & Hui, P. M. Spies in the minority game. *Phys Rev E* 77, 011106 (2008).

Slowly rotating neutron stars and hadronic stars

Shaoyu Yin

Abstract

The equations of state for neutron matter, strange and non-strange hadronic matter in the chiral SU(3) quark mean-field model are applied in the study of slowly rotating neutron stars and hadronic stars. The radius, mass, moment of inertia, and other physical quantities are carefully examined. The effect of the nucleon crust for the strange hadronic star is exhibited. Our results show that the rotation can increase the maximum mass of compact stars significantly. For a big enough mass of pulsars which cannot be explained as strange hadronic stars, theoretical approaches to increase the maximum mass are addressed.

Paper Reference: Shaoyu Yin, Jiadong Zang, and Ru-Keng Su, *Slowly rotating neutron stars and hadronic stars in the chiral SU(3) quark mean-field model*, Eur. Phys. J. A **43**, 295–301 (2010).

Third-Order Nonlinear Optical Susceptibilities of Colloidal Crystals

C. Z. Fan[1], J. P. Huang[1] and K. W. Yu[2]

[1] *Department of Physics and Surface Physics Laboratory (National Key Laboratory), Fudan UniVersity, Shanghai 200433, China*

[2] *Department of Physics and Institute of Theoretical Physics, The Chinese UniVersity of Hong Kong, Shatin, New Territories, Hong Kong*

Colloidal crystals are one kind of complex systems, in which the colloidal particles are orderly arranged. They can form different structures like the body-centered tetragonal (bct) [Figure 1.], body-centered cubic (bcc), and face-centered cubic (fcc) lattices. On the basis of the Ewald-Kornfeld formulation, we studied the effective third-order nonlinear optical susceptibilities for nondegenerate four-wave mixing and third-harmonic generation in colloidal crystals, which are made of graded metallodielectric nanoparticles suspended in a host fluid. Theoretical results show that both an enhancement and a red shift of the optical nonlinearity in such colloidal crystals appear due to the effects of local fields and lattice structure. Furthermore, the presence of the dielectric gradation is helpful to achieve large enhancement of nonlinearity at low frequencies.

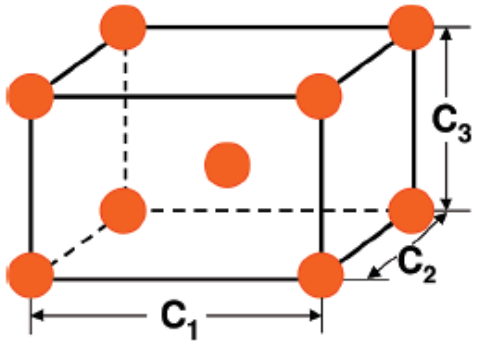

Figure 1. Schematic graph (not shown to scale) showing the location of two colloidal nanoparticles in a tetragonal unit cell. C_1, C_2, and C_3 are the three lattice constants.

References:

[1] C. Z. Fan, J. P. Huang and K. W. Yu, J. Phys. Chem. C 113, 18504 (2009).
[2] C. Z. Fan and J. P. Huang, Appl. Phys. Lett. 89, 141906 (2006).
[3] J. P. Huang and K. W. Yu, Phys. Rep. 431, 87 (2006).
[4] J. P. Huang, Y. C. Jian, C. Z. Fan, and K. W. Yu, J. Phys. Chem. C 112, 621 (2008).

Thermal conductivity of graphene nanoribbons

Zhixin Guo, Dier Zhang, and Xin-Gao Gong
Department Physics, Fudan University, Shanghai, 200433, China

We have investigated thermal conductivity of graphene nanoribbons (GNRs) with different edge shapes as a function of the length, width, and strain in use of the nonequilibrium molecular dynamics method. The thermal conductivity does not converge to a finite value with the increase of GNRs' length up to 60 nm, while follows a power law of $K \sim L^{\beta}$, indicating very high thermal conductivities and long PMFPs of GNRs. Moreover, the thermal conductivity is very sensitive to the edge shapes. It is found the zigzag GNR's thermal conductivity increases first and then decreases with the width increasing, while, the armchair GNR's thermal conductivity monotonously increases with width. A competitive mechanism is further proposed to explain such interesting phenomena. Very remarkable decrease of thermal conductivity is also obtained when a tensile/compressive uniaxial strain is applied on the GNRs[1].

[1] Zhixin Guo, Dier Zhang, and Xin-Gao Gong, Appl. Phys. Lett. 95，163103 (2009).

Interactions between Amyloid beta-barrel and anionic POPG membrane

Changzhongwe，Weiguanghong

Alzheimer’s disease (AD) is by far the most predominant illness of old life. It is characterized by neurotics plaques composed primarily of amyloid beta peptide (Aβ), which is a 40 - 42 amino acids residue peptide derived from the trans-membrane amyloid precursor protein (APP) during regular cell metabolism. Although the mechanism of normal metabolite going neurotoxic is not clear, numerous reports have provided evidences that the interactions between Aβ peptide and other cellular components, especially membranes, played a key role in the pathogenesis. One of the prevailing dogmas is that the Aβ disturbed the integrity and increased ion flux in artificial lipid and neuronal cells. The mechanism points to Aβ ion channel formation. However, as Aβ localized in the plasma membrane, little detailed structural information exists to indicate how Aβ induces these observed phenomena, which provides the motivation for our study. And we found that the Aβ 25-35 channel in anionic membrane bilayer POPG showed a preference of the conformation of Lys-inside, which had a stronger interaction with lipid environment in terms of disturbing negatively charged phosphorus heads.

Study on the energy relaxation dynamics of Ag, Cu nanoparticles embedded in soda-lime silicate glass fabricated by ion exchange

H. Zhou [1)], Y. C. Wang [1)], J. L. Ding [1)], Q. Chen [1)], J. X. Xu[2)], X. C. Yang[2)] and S. X. Qian [1)]

1) State Key Laboratory for Applied Surface Physics and Department of Physics,

Fudan University, Shanghai, 200433, China

2) School of Material Science and Engineering, Tongji University, Shanghai, 200092, China

Abstract:

Ag, Cu nanoparticles embedded in soda-lime glass were fabricated by ion-exchange followed by thermal annealing in hydrogen. In our samples, Ag, Cu nanoparticles were formed individually. A standard femtosecond pump-probe configuration to perform time-resolved measurements of transient differential transmission ($\triangle T/T$) was utilized. Near the surface plasmon resonance of Cu nanoparticles, the dynamic process includes only one fast decay component. The fast decay process about several hundred femtoseconds is regarded as hot electrons thermal equilibrium and transferring energy to lattices by interaction with phonons.

Quantum Criticality and Nodal Superconductivity in the FeAs-Based Superconductor KFe_2As_2

J. K. Dong,[1] S.Y. Zhou,[1] T.Y. Guan,[1] H. Zhang,[1] Y. F. Dai,[1] X. Qiu,[1] S.Y. Li[1*] and X. F. Wang,[2] Y. He,[2] X. H. Chen,[2]

[1]*Department of Physics, Surface Physics Laboratory (National Key Laboratory), Laboratory of Advanced Materials, Fudan University, Shanghai 200433, People's Republic of China*
[2]*Hefei National Laboratory for Physical Science at Microscale and Department of Physics, University of Science and Technology of China, Hefei, Anhui 230026, China*

The in-plane resistivity ρ and thermal conductivity κ of the FeAs-based superconductor KFe_2As_2 single crystal were measured down to 50 mK. We observe non-Fermi-liquid behavior $\rho(T) \sim T^{1.5}$ at $Hc_2 = 5T$, and the development of a Fermi liquid state with $\rho(T) \sim T^2$ when further increasing the field. This suggests a field-induced quantum critical point, occurring at the superconducting upper critical field Hc_2. In zero field, there is a large residual linear term κ_0/T, and the field dependence of κ_0/T mimics that in d-wave cuprate superconductors. This indicates that the superconducting gaps in KFe_2As_2 have nodes, likely d-wave symmetry. Such a nodal superconductivity is attributed to the antiferromagnetic spin fluctuations near the quantum critical point.

Mitochondrial signaling for Histamine releases in laser irradiated RBL-2H3 mast cells

吴祖辉

Abstract：The low power laser irradiation can promote the wound healing, but the mechanism is still not fully understood. We have found that the mast cells release the histamine under laser irradiations, the increased histamine release is probably one of the causes for promoting the wound healing since mast cells have been found to play positive roles in the process of wound healing. The action bands of laser irradiations were consistent with the absorption bands of cytochrome c oxidase, suggesting that cytochrome c oxidase is the photoacceptor. After laser irradiation, 1) the cytochrome c released from mitochondrial to cytosol reflecting an increased permeability of mitochondrial membrane, 2) the cytosolic alkalinization appeared, 3) $[Ca^{2+}]_i$ increased, and 4) finally the enhancement of histamine release occurred. When Bcl-2 was used to inhibit the permeability of mitochondrial membrane these cellular signaling from 1) to 4) were all suppressed obviously.As a photoacceptor, cytochrome c oxidase absorbs incident photons and initiates the mitochondrial signaling. When the signals are transferred from the mitochondrial to the cytosol, the cytosolic alkalinization appears leading to the opening of TRPV, a Ca^{2+} channel on the membrane, and an increment of $[Ca^{2+}]_i$. The increased $[Ca^{2+}]_i$ consequently mediates an enhanced histamine release. Such a responding chain is a suggested mechanism to understand the histamine release in RBL-2H3 cells under laser irradiations.

Dynamics of a strongly interacting Fermi gas

张文渊

Abstract

We generalize the quantum hydrodynamic equations and study the dynamics of a strongly interacting Fermi gas trapped in an anisotropic harmonic trap. By using this simple theory to simulate the expansion of the Fermi gas observed experimentally by O'Hara et al., Science, 298 (2002) 2179, we find that the density profiles of the system are well described by the Fetter-like form in the dynamical process in all spatial directions. We also discuss the anisotropic dependence on the expansion.

Coupling-induced synchronization of over-damped Stuart-Landau oscillators

X. X. Zhao[1], H. Nakao[2], and J. P. Huang[1]

1 Surface Physics Laboratory (National Key Laboratory) and Department of Physics, Fudan University, Shanghai, 200433, China

2 Department of Physics, Kyoto University, Kyoto, Japan

Abstract

The synchronization behavior of coupling-induced over-damped Stuart-Landau oscillators was analytically and numerically investigated. We firstly simulated two coupled over-damped Stuart-Landau oscillators, each of which is over-damped when isolated and then extended it to many coupled over-damped oscillators in simulation. We found that coupling can make over-damped oscillators to synchronize with each other. Then, we revealed analytically the conditions and constraints for over-damped oscillators to synchronize, both for attractive coupling and for repulsive coupling. Results showed that for attractive coupling, the group size can tune the system into complete synchronization; and for repulsive coupling, the synchronization patterns subject to a simple condition of zero-mean field.

References:

References:

[1] S. Y. Gu, Y. L. Jin, X. X. Zhao, and J. P. Huang, A possible population-driven phase transition in cicada chorus, 2009 *Comm.Theor. Phys.* **51**, 1055

[2] L. S. Tsimring, N. F. Rulkov,, M. L. Laren, and M. Gabbay, Repulsive Synchronization in an Array of Phase Oscillators, 2005 *Phys. Rev. Lett* **95**, 014101

Effect of both metal acupuncture and laser stimulation on skin resistance

张弛

Abstract

Acupuncture is a very useful form of traditional Chinese medicine that appeared over thousands of years. In this paper, we studied the effect of both metal acupuncture and laser stimulation on skin resistance in 12 healthy volunteers (mean age 25 years, 9 males and 3 females). We used a data collector connected with a computer to monitor and record the voltage signal and calculate the resistances of volunteers. The study shows that both sensible metal acupuncture and feeless laser stimulation can lead to a significant decrease of skin resistance. Further, we studied how sweating affect the resistance decrease in acupuncture. We found that sweating is not the main reason for the decrease of skin resistance; even humidity is the main factor of skin resistance.

Tunable surface plasmon polaritons of silver capped two-dimensional colloidal crystals on stretchable substrate

Xiaolong Zhu, Lei Shi, Xiaohan Liu and Jian Zi
PBG Group, Department of Physics, Fudan University, Shanghai, China

Abstract

A simple and comprehensive method for fabricating metallically capped two-dimensional (2D) colloidal crystals on elastic polydimethylsiloxane (PDMS) substrate is demonstrated. This composite supports surface plasmon polaritons, whose energies are sensitive to the geometry of the 2D lattice structures. Because of the high ductibility of elastic PDMS membrane, the lattice structures of metallically capped array can be controlled by expanding the PDMS membrane. Such kind of samples can be stretched up to 70% strain with neither significant fractures and ripples in appearance, nor any disorders of the lattice and intensity decreases of the reflected light observed. This provides a promising approach to tune surface plasmon polaritons, thus realize flexible plasmonic devices with strain sensitivity and reversible-repeatable color changing.

Research in fabrication CIGS solar cells

Hao Xu, Fang Lu
Department of Physics, Fudan University, Shanghai 200433, China

CIGS is abbreviation of Cu(In, Ga)Se_2, a kind of Ⅰ-Ⅲ-Ⅵ semiconductor materials. Its band gap is in the range of 1.04eV~1.67eV, absorption coefficient is up to $10^5 cm^{-1}$, which make it a promising candidate of thin film solar cell. Up to now, heterojunction CIGS/CdS/ZnO:Al based solar cell have already reached a conversion efficiency of 19.9%.

Aluminum-doped zinc oxide (AZO) is a promising transparent conductive oxide material for application as window layer in CIGS solar cells, flat panel display, and optoelectronic devices. Besides high conductivity and optical transmittance in visible region, AZO film has a lot of advantages, such as non-toxicity, low cost, material abundance, relatively low deposition temperature, and high stability. So basic research in AZO is necessary for the fabrication of CIGS solar cell.

A buffer lay of CdS(50-80nm) was deposited on CIGS absorber by Chemical bath deposition. Owing to the favorable properties of CdS as a heterojunction partner, it is also important to observe its surface appearance.

Realization of modulating broadband emission from Er-Tm co-doped calcium boroaluminate glasses by dual-wavelength pumping

Mingzhu Li, Fang Lu, Fei Xu, Xiao Wang and Lingling Zheng

Surface Physics Laboratory (National Key Laboratory), Fudan University, Shanghai

We present the spectroscopic characterization of Er-Tm co-doped calcium boroaluminate (CABAL) glasses. This glass was an improved glass with a fewer OH^-. For the first time we study and optimize the Er-Tm co-doped fiber amplifier with a dual-wavelength (795 + 476 nm) pumping scheme. The full width at half maximum (FWHM) can reach 500 nm in the wavelength rang from 1.3 -2.0 m by controlling the power ratio of two pump light (P_{476} / P_{795}). The Photoluminescence (PL) spectra shows four characteristic peaks at 1.46, 1.53, 1.58 and 1.80 m, related to Tm^{3+}:$^3H_4 \rightarrow {}^3F_4$, Er^{3+}: $^4I_{13/2} \rightarrow {}^4I_{15/2}$, Tm^{3+}: $^1G_4 \rightarrow {}^3F_2$ and Tm^{3+}: $^3F_4 \rightarrow {}^3H_6$. The power dependence of the PL centered at the four peaks has been investigated. It is shown that the shape of the broadband can be changed as changing the power of the pump light. In this paper, we use numerical simulations and experimentally obtained fiber characteristics. The experimental results are compared for the glasses pumped at a single wavelength in the 795nm band. A new energy transfer is also studied with a dual-wavelength pumping.

A Graphine-Induced Transformation of Peptide Secondary Structure

Abstract

The pathogenesis of some diseases featuring amyloids is associated with an α-β conformational transitions of part of the proteins. Recent experimental data show that The polypeptide (DELERRIRELEARIK) would undergo a structural transtion from α-helical to β -sheet-like secondary structure upon the addition of graphite particles to the peptide solution[1]. However, it is difficult to investigate the detailed process of conformational transition in experiments. By molecular dynamic simulation we can study the peptide conformational trnasition mechanism induced by graphine.

References

1. Xiaobo Mao, Yibing, Wang, Lei Liu, Lin Niu, Yanlian Yang, and Chen Wang, *Langmuir*, **2009**, 25(16), 8849-8853.
2. Burkhard, P., Meier, M., and Lusig, A., *Protein Sci.*, **2000**, 9, 2294-2301

High Voltage Termination Design and Optimization for IGBT by TCAD tools

Runyan Miao, Fang Lu, Dawei,Gong
Surface Physics Laboratory (National Key Laboratory), Fudan University, ASMC, Shanghai

IGBT (Insulted Gated Bipolar Transistor) combine the best attitude of bipolar transistors and power MOSFETs, which have features such as voltage control, high input impedance, low driving power, easy control circuits, low switching loss, high turn-on and turn-off speed and high operation frequency and so on. Because of these features, IGBTs now have been widely used in applications for high power and voltage circuits, and therefore breakdown voltage is an important parameter of IGBTs. As high-voltage junction termination is a common measure to improve IGBTs' voltage rating, great attentions have been paid on junction termination technology and its optimizations. Trench structure significantly increases the breakdown voltage from 319 volts to 851 volts. With the help of field plate, the termination structure finally avalanches at 1165 volts. These design and optimizations above are done through TCAD tools, which make the research efficient and costless.

A teaching laboratory on electron optics

Zhang Ye-qing, Xia Hui, Hu Li-peng, Liu Jie-meng, Le Yong-kang
Fudan Physics Teaching Lab, Shanghai, People's Republic of China

Abstract: We started with the investigation on the focus of electron beam in a single trace oscilloscope CRT. SIMION software was employed to simulate the focus effect in dependence of different parameters, such as the local distribution and energy distribution of the initial electrons, voltage of the lens electrodes, etc.

Ordered GeSi quantum rings grown on patterned Si (001) substrates

Jian Cui, Yingjie Ma, Yongliang Fan, Zuimin Jiang, Zhenyang Zhong*

Surface Physics Laboratory (National Key Laboratory), and Department of Physics, Fudan University, Shanghai 200433, China

Ordered silicon-based nanostructures have attracted considerable attentions due to their unique properties and potential applications in various novel devices including field-emission displays, nanoelectronic and nanophotonic devices [1, 2]. It is convenient to use nanosphere lithography (NSL) technology to fabricate periodic patterns for it is cheap but effective. NSL has been used to fabricate periodic SiGe quantum dots (QDs) with the period down to 100 nm. [3] Self-assembled quantum ring (QR) is a kind of newly discovered nanostructures. [4] The special topological configuration has shown interesting quantum effects, e. g. persistent current in normal metal rings. [5] In this report, we will present highly ordered GeSi QRs in large areas grown on patterned Si (001) substrates by molecular beam epitaxial.

The inverted pyramid-like pits arranged in a hexagonal lattice on Si (001) substrates were fabricated by reactive iron etching (RIE) and NSL technology [6]. The main fabrication processes of the pattern were shown in Fig. 1. After the hexagonal PS pattern was formed (Fig. 1 (a)), the pattern was etched by RIE to shrink the coverage of PS (Fig. 1 (b)). This step is necessary to the subsequent formation of QRs, because the large distance between QDs ensures the independent development of QRs when capping. The ordered inverted pyramid-like pits were obtained by selective etching of Si in KOH solution. The ordered GeSi QRs were then grown via a two-step process. First, ordered dome shaped GeSi QDs were grown on the patterned substrates at 610 °C, as shown in Fig. 2 (a). Second, a thin Si capping layer was deposited at 610°C. By controlling the amount of deposited Si, the GeSi QDs transform into GeSi QRs [4].

Then highly ordered GeSi QRs arrays were formed, as shown in Fig. 2 (b). The period of rings was pre-determined by the pattern on Si substrates, which can be readily modulated by using PS nanospheres in different sizes. The size of rings was closely associated with the size of capped GeSi QDs and the Si capping process. Parameters including the size of PS nanospheres, RIE processing parameters, growth temperature and thickness can be adjusted and optimized to control the size and periods of QRs. These ordered GeSi QRs may have unique properties.

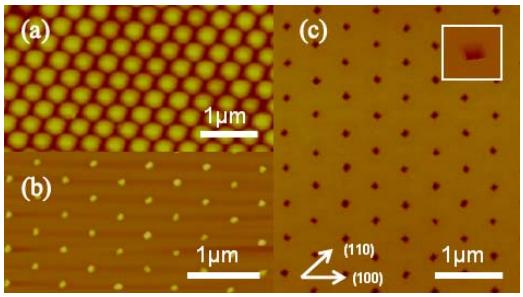

FIG. 1 (a) PS pattern, (b) RIE processed pattern, (c) KOH selectively etched pattern,

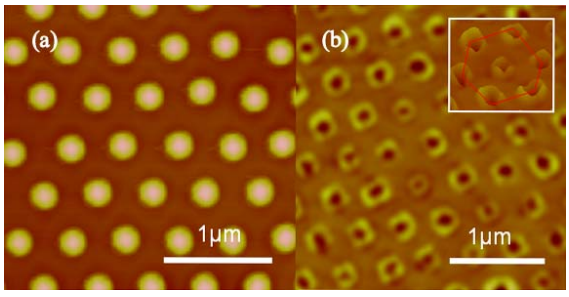

FIG. 2 (a) Ordered QD (b) Ordered QR grown by capping a thin Si layer

* zhenyangz@fudan.edu.cn

[4] V. V. Poborchii, et al., Appl. Phys. Lett. **75**, 3276 (1999).

[5] L.J. Heyderman, et al., Appl. Phys. Lett. **85**, 4989 (2004).

[6] P. X. Chen, et al., Nanotechnology. **20**, 095303 (2009).

[7] J. Cui, et al., Appl. Phys. Lett. **83**, 2079 (2003).

[8] H. Bluhm, et al., Phys. Rev. Lett. **102**, 136802 (2009).

[9] H. W. Deckman, et al., Appl. Phys. Lett. **41**, 377 (1982).

Configurations of Lipid Vesicles with Attached Spherical Particles

Cao Siqin[1], Wei Guanghong[1], Jeff Z. Y. Chen[2]

[1] *Fudan University, Shanghai, China;* [2] *University of Waterloo, Ontario, Canada*

Abstract

Wrapping of a spherical colloidal particle by the vesicle membrane is investigated. The properties of adhesion are studied for different vesicle geometries such as sperical, prolate, bolate, stomatocytes, 3-shape. By systematically calculation of the axial-symmetry case with Helfrich curvature energy model, the bending and adhesion energy of different adhesions are obtained.

Steered Molecular Dynamics

Yu Wang and Jiping Huang
Phys. Dept., Fudan Univ., Shanghai, People's Republic of China

Abstract

We investigate the dynamics of the detachment of single polyethylene (PE) chains from a strongly adsorbing surface in vacuum by steered molecular dynamics method. Various statistical properties, including the mean-square end-to-end distance $< R^2 >$, the mean-square radii of gyration $< S^2 >_{xy}$、$< S^2 >_z$, the shape factor $< \delta >$, the torsion angle distribution, the average surface adsorption energy $< U_a >$, the average total energy $< U >$, and the average force $< f >$, are analyzed. The relationship between the average force $< f >$ and the pulling velocity v shows two distinctive regions: a weakly dependence region as $v<10^{-2}$ Å/ps and a strongly dependence region as $v>10^{-2}$ Å/ps. Remarkably, the PE chain manifests force hysteresis under sequential stretching and releasing.

Keywords: Steered molecular dynamics; conformation; elasticity; adsorbed polyethylene chain

Magneto-transport in Single Crystalline Bismuth Thin Films

Shunhao Xiao*, Dahai Wei, and Xiaofeng Jin

Surface Physics Laboratory, Fudan University, Shanghai 200433, China

Bulk Bi is a prototype semimetal. The possible existence of its semiconductor phase in thin film has attracted lots of attentions both theoretically and experimentally, yet is still a controversial issue [1-4]. In this work, the conductance and Hall coefficient of a series of single crystalline bismuth films epitaxially grown on BaF_2(111) were measured as a function of film thickness and temperature, and the semimetal to semiconductor transition was clearly observed. The transport behavior in Bi film can be well explained by considering the coexistence of a metallic surface state and a semiconductor film.

[1] V. B. Sandomirskii, JETP, 25,101 (1967).
[2] C. A. Hoffman, etc. Phys. Rev. B. 48, 11431(1993), Phys. Rev. B. 51, 5535 (1995)
[3] H. T. Chu Phys. Rev. B. 51, 5532 (1995)
[4] T. Hirahara, etc. Appl. Phys. Lett. 91, 202106 (2007)

Si-SiO_x core-shell nanowires induced by metallic Fe on Si wafers

Tianxiao Nie [†,‡], Zhigang Chen[‡], Yueqin Wu[†], Jiale Wang[†], Jiuzhan Zhang[†], Yongliang Fan[†], Xinju Yang[†], Zuimin Jiang [*,†] and Jin Zou [*,‡]

[†]State key laboratory of surface physics, Fudan University, Shanghai 200433, China, and [‡]Materials Engineering and Centre for Microscopy and Microanalysis, The University of Queensland, QLD 4072, Australia

*(Z. M. J.) E-mail: zmjiang@fudan.edu.cn, (J. Z.) E-mail: j.zou@uq.edu.au

Si-SiO_x core-shell nanowires with a length of hundreds of micrometers and average diameters of 40 ~ 90 nm were fabricated by directly heating Si wafer coated with metallic Fe. This novel core-shell nanowire has a diamond structure Si core with 5~8 nm in diameter grown along [111] growth direction and a much thicker amorphous SiO_x shell. Through careful study of the synthesis conditions and microstructural characteristics of synthesized nanowires, a temperature dependent Fe-FeO_x core-shell catalyzed solid-liquid-solid mechanism is proposed to explain the growth of Si-SiO_x core-shell nanowire.

Tunning anomalous Hall conductivity in L1(0) FePt films by chemical long range ordering

M. Chen, Z. Shi, S. M. Zhou
Surface Physics State Laboratory and Department of Physics, Fudan University, Shanghai 200433, China

Abstract

Effect of spin orbit coupling on anomalous Hall conductivity (AHC) has for the first time been experimentally studied, by exploiting L1(0) FePt films. Contributions of the skew scattering and the side jump to the AHC change non-monotonically with chemical long range ordering S and the intrinsic one changes monotonically. They are all proportional to spontaneous magnetization M_S. The spin orbit coupling strength is indicated to increase with increasing S. *As a new approach,* the AHC in ferromagnetic alloy films can be controlled by chemical long range ordering.

The effect on weak lensing in dark sectors' mutual interacting models

Jian-hua He and Bin Wang

We have investigated the impact of mutual interaction of dark sectors on the cosmological large scale structure. We find that Weak Lensing effect as a promising tool to probe the nature of dark energy could also be deemed as a potential tool to measure the influence of interactions among dark sectors.

Novel Six-Branched Compounds with Extremely Large TPA Cross sections and Good Optical limiting Properties

Yaochuan Wang[a,b], Hui Zhou [a,b], Jinliang Ding [a,b], Qiang Chen [a,b] and Shixiong Qian[a)*]

Physics Department, Fudan University, Email: *sxqian@fudan.ac.cn*

Abstract

A tri-branched compound **T03-a** with 1,3,5-Triazine as the core together with another two novel **T03-a** based six-branched compounds **T03-b**, **T03-c** have been synthesized. Femtosecond Z-scan technique, two-photon excited fluorescence, two-color pump-probe spectroscopy, together with steady absorption and fluorescence emission measurements, were employed to investigate the optical properties and the ultrafast dynamics of these compounds in chloroform solutions. The two-photon absorption cross sections of six-branched compounds **T03-b** and **T03-c** were determined to be 4196 GM and 5918 GM showing 9.4-fold and 13.2-fold enhancement over that of the tri-branched counterparts **T03-a** (447GM). The enhancement was attributed to cooperative interaction between branches, the increased chromophore intensity as well as the increased delocalization of the electron cloud. Obvious fluorescence quenching and aggregation-induced enhancement of two-photon fluorescence emission were observed in compounds **T03-b** and **T03-c**. The excited state dynamics results reveal an ultrafast charge localization from higher excited state to the ICT state in picosecond domain, and different relaxation dynamics happen in the three compounds. The fluorescence quenching of compounds **T03-b** and **T03-c** was also discussed by excited state dynamic results. The two-photon absorption based optical limiting properties of these compounds in the femtosecond domain were also investigated, and the results indicate these materials being good candidates for optical limiting devices.

Transient Photovoltage Measurement Applied to Exciton Dissociation and Built-in Field Research

武博

Exciton dissociation and charge collection are both essential step in photovoltaic process, but in small organic molecule solar cells, there is lack of realization on these two steps. In this work, we applied photovoltage measurements to our research, giving insight of exciton dissociation at organic/electrode interface and the built-in electric field behaviors. In the end, I provide a theoretical model with energy level diagram, in order to explain our results，which could bring on further research.

Complicated Hall resistivity at low temperature in $Fe_{0.04}Si_{0.96}$ film

Y. Q. Xu, W. F. Su, J. Cui and Z. M. Jiang

Phys. Dept., Fudan Univ., Shanghai, People's Republic of China

In Fe doped Si film (4%) we have observed complex conduction mechanisms and nonmonotonic field-dependent anomalous Hall effect (AHE). The complicated field-dependent Hall resistivity and positive magnetoresistance at low temperatures can be well explained by two-carrier model. It shows that the two kinds of carriers in the film are holes, one is from the thermally activated conduction involving the electron transition from valence band to shallow acceptor levels; while the other is from the holes hopping between localized states within the impurity band.

Faster uptake and higher photodynamic therapy effect of octagonal carboxyl phthalocyanine than that of aluminium tetrasulfonated phthalocyanine

赵金凤

Abstract: Octagonal carboxyl phthalocyanine (Pc-COOH) is a new synthetic photosensitizer (PS) of phthalocyanine (Pc) class, which has unique properties, such as, faster uptake (about 3h) than that of aluminium tetrasulfonated phthalocyanine (AlTSPc)(about 6~7h) in human nasopharyngeal carcinoma cells (KB cells) and human hepatoma cancer cells(QGY cells). Though its fluorescence quantum yield is smaller than that of the later, it has high biocompatibility, because of those eight COOH groups can be combined with NH_2 groups of protein of membrane easily. Likewise, its photodynamic therapy(PDT) efficiency to carcinoma cells is better than that of traditionally AlTSPc which was extensively used in PDT.

A Financial Market Model

G. Yang[1], K. Wang[1], B. Zhao[1], L. Zheng[1], T. Y. Fan[1], C. H. Wang[1],
W. Wang[1], L. Zhao[1], Y. Chen[2] and J. P. Huang[1]
[1]Department of Physics, Fudan University, Shanghai 200433, China
[2]Department of Systems Innovation, Graduate School of Engineering, University of Tokyo, Tokyo 113-8656, Japan

Abstract

For a long time, people are trying to predict the trend of price changes. But even Isaac Newton exclaimed that he could calculate celestial motion, but could not calculate human madness. It is also an attractive research subject in Econophysics. Here we present a financial market model using the technique of agent-based modeling (ABM). In the model, we mimic the human decision-making process of buying or selling a certain stock. We find that the trends of the simulated stock price are similar to what we see in the real markets. In particular, we also use the Bouchard-Sornette formula to do the European option pricing. With the parameters properly adjusted, the option prices based on simulated data are well fitted with the ones based on SH index (2000.1.2-2009.10.27).

Electronic structure transition: the driving force behind magnetic and lattice structure transitions in NaFeAs

C. He[1], Y. Zhang[1], B. P. Xie[1], X. F. Wang[2], L. X. Yang[1], B. Zhou[1], F. Chen[1], X. H. Chen[2], M. Arita[3], K. Shimada[3], H. Namatame[3], M. Taniguchi[3], J. P. Hu[4], **D. L. Feng[1*]**

[1]*Department of Physics, Surface Physics Laboratory (National Key Laboratory), and Advanced Material Laboratory, Fudan University, Shanghai 200433, P. R. China*

[2]*Department of Physics, University of science and technology of China, Hefei, Anhui 230027, P. R. China*

[3]*Hiroshima Synchrotron Radiation Center and Graduate School of Science, Hiroshima University, Hiroshima 739-8526, Japan*

[4]*Department of Physics, Purdue University, West Lafayette, Indiana 47907, USA*

Keywords: Angle resolved photoemission spectroscopy, NaFeAs, Electronic structural transition

One of the mysteries in iron-based high-temperature superconductors is that a spin density wave (SDW) transition is always accompanied by a structure transition. The ubiquitous appearance of the SDW transition and structural transition in different families of iron-based systems makes it crucial to understand their nature and origin. So far there is no hard experimental evidence to establish a general relationship between those two transitions. Here we report a strong evidence to unveil this mystery. The electronic structure of NaFeAs is systematically studied with high resolution angle-resolved photoemission spectroscopy on high quality single crystal. An electronic structure transition with large portions of electronic band shift is found to take place around the lattice structure transition temperature, and the shift smoothly increases as the temperature lowers through the SDW transition. In addition, band folding due to magnetic order emerges around structural transition. Our results give direct evidence that the electronic structure transition rather than the Fermi surface nesting provides the driving force of both the lattice structural and magnetic transitions.

Enhancement of perpendicular magnetic anisotropy of TbFeCo films by oxide additives

刘尊

Abstract

TbFeCo and SiO_2-TbFeCo granular films were prepared by magnetron co-sputtering. Transmission electron microscopy shows that SiO_2-TbFeCo granular films have more nanocrystal than TbFeCo films. For TbFeCo and SiO_2-TbFeCo granular films, the coercivity has similar variation trends as a function of film layer thickness. At small thickness, the coercivity in SiO_2 -TbFeCo films is enhanced greatly,in comparison with TbFeCo film. In magnetic force microscope image, average magnetic domain size is reduced, indicating a reduction of exchange interaction in SiO_2-TbFeCo granular films.

Surface and bulk electronic structures of LaOFeAs studied by angle resolved photoemission spectroscopy

Using a laser beam to pump non-resonantly, polarition degenerate four wave mixing (DFWM) oscillation is reported in ZnO one-dimensional whispering gallery microcavities at room temperature. We observe a directional elastic scattering of two cavity polaritons above the threshold of DFWM effect in our system. The intensity of DFWM signal has a nonlinear increase when the pump power is enhanced. We use rate equations to describe the evolution of the parametric scattering process and the theoretical calculation agrees well with the experiment results.

Magnetization dynamics and Gilbert damping in magnetic thin film probed by Time resolved Magneto-Optical Kerr Effect

Ming Yi[1], Zhifeng Chen[2], Daxin Chen[2], T. S. Lai[2] and S. M. Zhou[1]
[1]*Department of Physics, Surface Physics Laboratory (National Key Laboratory), Fudan University, Shanghai 200433, People's Republic of China*
[2]*State Key Laboratory of Optoelectronic Materials and Technologies, School of Physics and Engineering,, Sun Yat-Sen University, Guangzhou 510275, People's Republic of China*

Abstract
Surface magneto-optic Kerr effect (SMOKE) has became much easier to research ultrafast process of magnetic materials with the help of femtosecond laser system and pump-probe technique. Time resolved magneto-optic Kerr effect system (TRMOKE) had been built to measure the ultrafast dynamics process of in-plane magnetized materials. Some results of demagnetization of magnetic thin films had been collected. We use the Tri-temperature model to study the relaxation of electron, spin and lattice. Recently we are concerned in the Gilbert damping and ultrafast process of spin polarized magnetic films. The measurements had bee taken in CFAS half metal materials with different annealing temperatures by TRMOKE cooperated with Lai's group of Sun Yat-Sen University, Guangzhou.

High-resolution angle-resolved photoemission spectroscopy study of the electronic structure of $EuFe_2As_2$

Bo Zhou[1], Yan Zhang[1], Le-Xian Yang[1], Min Xu[1], Cheng He[1], Fei Chen[1], Jia-Feng Zhao[1],Hong-Wei Ou[1],
Jia Wei[1], Bin-Ping Xie[1], Tao Wu[2], Gang Wu[2], Masashi Arita[3], Kenya Shimada[3], Hirofumi Namatame[3],
Masaki Taniguchi[3], X. H. Chen[2], and D. L. Feng[1]
[1]*Department of Physics, Surface Physics Laboratory (National Key Laboratory), and Advanced Materials Laboratory, Fudan University, Shanghai 200433, People's Republic of China*
[2]*Hefei National Laboratory for Physical Sciences at Microscale and Department of Physics, University of Science and Technology of China, Hefei, Anhui 230026, People's Republic of China*
[3]*Hiroshima Synchrotron Radiation Center and Graduate School of Science, Hiroshima University, Hiroshima 739-8526, Japan*

We report the high-resolution angle-resolved photoemission spectroscopy studies of electronic structure of $EuFe_2As_2$. The paramagnetic state data are found to be consistent with density-functional calculations. In the antiferromagnetic ordering state of Fe, our results show that the band splitting, folding and hybridization evolve with temperature, which cannot be explained by a simple folding picture. Detailed measurements reveal that a tiny electron Fermi pocket and a tiny hole pocket are formed near (π,π) in the $(0,0)$-(π,π) direction, which qualitatively agree with the results of quantum oscillations, considering k_z variation of Fermi surface. Furthermore, no noticeable change within the energy resolution is observed across the antiferromagnetic transition of Eu^{2+} ordering, suggesting weak coupling between Eu sublattice and FeAs sublattice.

* B. Zhou et al., Phys. Rev. B 81, 155124 (2010)

Magnetic transport properties in epitaxial Fe_3O_4 thin film

Chunrui Hu Yizheng Wu
Surface Physics Laboratory ,Department of Physics,
Fudan University

Fe_3O_4 is one of the important 3*d transition-metal* oxides, high Curie temperature (858 K), presence of a metal-insulator transition MIT at around 120 K (Verwey transition),and spin polarization rate reaching 100% in theory. Therefore, Fe_3O_4 is expected to exhibit suitable properties for its implementation in spintronic devices. X-ray diffraction experiments indicate the epitaxial growth with high crystal quality. The resistivity measurements show the characteristic of the Verwey transition. Magnetoresistance reach maximum round at 110k. pinnacle in hard axis may be produced by Phall effect. Anisotropy field can be gained by fitting the torque, which could be gotten by Phall effect.

I-V characteristic of double layer quantum dots studied by Conductive AFM

Yifei Zhang, Jianhui Lin, Jian Cui, Jiale Wang, Shihua Zhao, Xinju Yang
Surface Physics Laboratory (National Key Laboratory), Fudan University, Shanghai 200433

Interest in zero-dimensional quantum dots has been intense which lies mostly in their technological potential as well as their fundamental electrical properties. We have investigated the electrical properties of vertically coupled self-assembled GeSi quantum dots grown on p-type silicon substrates using Conductive Atomic Force Microscope at room temperature. Different Current characteristics are observed when measuring single/double layer quantum dots. The I-V curve also showed relationship with the dot density of the sample. The origin of this phenomenon is supposed to be delocalization of the electron and hole wave functions in the direction of coupled dots.

Elementary excitations in Multi-Component BEC

Rukuan Wu

Quantum phase transition(QPT) and entanglement are two important concepts in different fields of physics, the former corresponds a qualitative change in ground state and has been studied for many years in many-body systems, the latter is regarded as a resource of quantum quantum procession and believed to improve the calculation speed of the quantum computation. Recently, people find there exists a certain correlation between QPT and entanglement in some spin-chain system. In this kind of systems the entanglement is maximal at transition point or in the vicinity of transition point the entanglement has the scaling behavior. We prove that there exists a quantum phase transition in Multi-Component Bose-Einstein Condensation and the elementary excitation spectrums have the singularity in the vicinity of critical point. When the parameter tends to the transition point, Mean-Field Approximation is not suitable to calculate the elementary excitation spectrums.

Magneto-transport in Single Crystalline Bismuth Thin Films

Shunhao Xiao*, Dahai Wei, and Xiaofeng Jin

Surface Physics Laboratory, Fudan University, Shanghai 200433, China

Bulk Bi is a prototype semimetal. The possible existence of its semiconductor phase in thin film has attracted lots of attentions both theoretically and experimentally, yet is still a controversial issue [1-4]. In this work, the conductance and Hall coefficient of a series of single crystalline bismuth films epitaxially grown on BaF_2(111) were measured as a function of film thickness and temperature, and the semimetal to semiconductor transition was clearly observed. The transport behavior in Bi film can be well explained by considering the coexistence of a metallic surface state and a semiconductor film.

[1] V. B. Sandomirskii, JETP, 25,101 (1967).
[2] C. A. Hoffman, etc. Phys. Rev. B. 48, 11431(1993), Phys. Rev. B. 51, 5535 (1995)
[3] H. T. Chu Phys. Rev. B. 51, 5532 (1995)
[4] T. Hirahara, etc. Appl. Phys. Lett. 91, 202106 (2007)

Dynamics of an entangled Bose-Einstein condensate with internal tunneling

王金龙 施郁

Internal tunneling can be considered in a entangled system which contains two type of atoms and each atom with two components. We can see that when internal tunneling happened, the evolutions of atom number and psedo-spin have some periodical properties and in some special parameter there are some nonlinear effects with the vary of time.

Effects of Shear Stress on Intracellular Calcium Change and Histamine Release in Rat Basophilic Leukemia (RBL-2H3) Cells

魏斐 周鲁卫

abstract

A mast cell RBL-2H3 was used to study cellular responses to shear stress generated by a rotating rotor in a cell dish. The intracellular calcium was studied by confocal fluorescence microscopy with Fluo-3/AM staining and the released histamine was measured with a fluorescence spectrometer using *o*-phthalaldehyde (OPA) staining. An elevation of [Ca2+] occurred immediately after the shear stress, followed by histamine release. Furthermore, Ruthenium red, a transient receptor potential vanilloid (TRPV) inhibitor, could effectively block the shear stress–induced histamine release, suggesting that TRPV membrane proteins are the likely targets of the shear stress.

Direct observation of polariton waveguide in ZnO nanowire at room temperature

凌艳菁

We report the direct experimental evidence of polariton waveguide, a well confinement of the propagation of polariton at room temperature. By using the angle resolve measurement, we obtained the dispersion of strong coupling in ZnO whispering gallery microcavity. While with the separation between the excitation laser and collection lens, we observed the propagation of polariton along the ZnO nano wire. This implies that the ZnO nano wire can be served as good candidate for one dimensional waveguide of polariton and provides the opportunity for polariton waveguide-based device.

准周期光晶格中的玻色冷原子气体

Yue Dai and Yu Shi
Department of Physics, Fudan University, Shanghai 200433, China

周期结构中的波是 Bloch 波，它是非定域的；而无序会导致 Anderson 局域化。准周期结构介于周期结构与无序结构之间，利用准周期光晶格，通过调控一些参数，可以研究定域-非定域的相变现象。我们通过对 Fibonacci 光格中冷原子气体的研究，探讨相互作用导致的 Mott 绝缘体相-超流相之间的相变，并和周期结构、无序结构进行比较。

Reference

[1] RMP, **78**, 179 (2006);
[2] PRB, **35**, 1020 (1987);
[3] PRA, **77**, 063605 (2008);
[4] PRB, **40**, 546 (1989).

Effects of contrarian behavior on resource distribution

Yuan Liang*, Jiping Huang*

*Department of Physics, State Key Laboratory of Surface Physics, and Key Laboratory of Micro and Nano Photonic Structures (Ministry of Education), Fudan University, Shanghai 200433, China

Abstract

Different private information of investors leads to cognitive biases in market Investment. Market behavior is essentially a collective phenomena, in which various Individual behaviors exist including contrarian behavior. Contrarian behavior is that a person with a preference takes decisions against the majority view prevalent in the group of which they are a part. It is usually adopted by experienced investors in stock market trading. Contrarian behavior is the most profitable way in stock investment, if operate properly. In order to study the effect of contrarian behavior on economic systems, we introduce contrarian behavior individuals into a agent-based model called MDRAG and calculate efficiency and stability of the whole systems in different resource distribution. As the contrarian behavior agents increase, we found that economic system could reach most stable state in small resource bias, even in equilibrium of resource distribution. Moreover, we observe that contrarian behavior improved efficiency of resource allocation system. This work is helpful to understand the reverse operation and human behavior in real market.

Quantum transport in Hexagonal bilayer graphene

Zhaoli Ma and Weidong Sheng
Phys. Dept., Fudan Univ., Shanghai, People's Republic of China

Recently, the transport in various graphene structures has been deeply investigated, we study the bilayer graphene which is the cornerstone for the future application on Integrated Graphene Circuits. We set the model to simulate the overlap of two wires, which are graphene ribbons in our model. And the intersection is a hexagonal graphene dot. We apply the lattice Green's function and Landauer formula to obtain the conductance. In our result, we can see that the inter-layer coupling and the width of the wires strongly influenced the conductance of the structure.

Enhanced PC fluorescence by the gold nanorod surface plasma and its function in curing cancer cells

李磊

Abstract

During the past few years photodynamic therapy (PDT) has become a noninvasive treatment modality for a range of diseases including cancers.[1-4] Aluminium tetrasulfonated phthalocyanine (AlTSPc) is a nontoxic PDT drug, which is FDA approved for clinical trials against tumors.[5] But the time of entering cancer cells for the AlTSPC is a little long, and also its fluorescence isn't strong enough for us to detect. The gold nanorod will help us to work out the problems.

The hexadecyl trimethyl ammonium bromide(CTAB) covered gold nanorod makes the nanorod dissolve in the water, and also the gold nanorod get positive charge on its surface. Because of the negative charge on the AlTSPc, we can connect the AlTSPc with the gold nanorod forming AlTSPc-CTAB-gold nanorod. The new drug enter the cells much more quickly than the AlTSPc does and the fluorescence intensity is much more higher than the AlTSPc.

Critical phenomena of holographic superconductors in Einstein-Gauss-Bonnet Gravity

刘云旗

Abstract: We investigate the critical behaviors for the holographic superconductors in a Gauss-Bonnet black hole background by the perturbation method. We find that the critical temperature, thermodynamic susceptibility, correlation length, static susceptibility and relaxation time depend on the Gauss- Bonnet parameter and the dimension of the AdS space. However, we demonstrate that the critical exponents, which take the standard mean-field values, are independent of the Gauss-Bonnet factor and the dimension.

Holographic superconductors in AdS soliton away from the probe limit

彭严 王斌

Abstract

We investigate behaviors for the holographic superconductors in a AdS soliton Background at the case that the scalar field condensed so heavily that we have to consider the condensed matter's backreaction to the metric. We find that the backreaction made the scalar field condense more difficultily., However we find the ciritical parameter depend on the backreaction not sensitive .

SPIN STRUCTURE IN THE DOMAIN WALL OF MAGNETIC STRIPE PHASE

G. Chen[1], J. Li[1], Adrian Quesada[2], A.K. Schmid[2], and Y. Z. Wu[1]

[1] Department of Physics, Applied Surface Physics State Key Laboratory, and Advanced Materials Laboratory, Fudan University, Shanghai 200433, P. R. China
[2]NCEM, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

The formation of magnetic stripe domains at the so-called spin reorientation transition (SRT) of an ultrathin magnetic film is shown to be associated with the two-dimensional (2D) magnetic long range order. So understanding the spin structure of magnetic stripe domains at the SRT of a magnetic ultrathin film becomes fundamentally important to the understanding of the 2D magnetic nature. The spin structure of the domain wall could be essential to the formation of the stripe phase, however all theoretical studies only assumed the Bloch-type domain wall which has the in-plane component along the stripe direction. So far no experimental effort on the stripe domain wall has been reported.

In this contribution, we will present our experimental study on the magnetic stripe domain in Fe(x ML)/Ni(2ML)/ Cu(001) system imaged by spin-polarized low energy electron microscopy (SPLEEM). Here 2ML Ni layer was used to avoid the structural phase transition of fcc Fe grown on Cu(001). SPLEEM technique can image both out-of-plane and in-plane component of magnetic domain with ~20nm resolution. As shown in Fig.1, in most experiments, we only observed the Néel-type wall structure which contains the in-plane magnetization component perpendicular to the stripe direction. The Bloch-type domain can only be observed for very few times, indicating the Néel-type domain wall is more stable. The in-plane magnetization of adjacent domain walls are found anti-coupled with each other. Moreover, we will show the real-time study on the stripe domain dynamics within a perpendicular magnetic field.

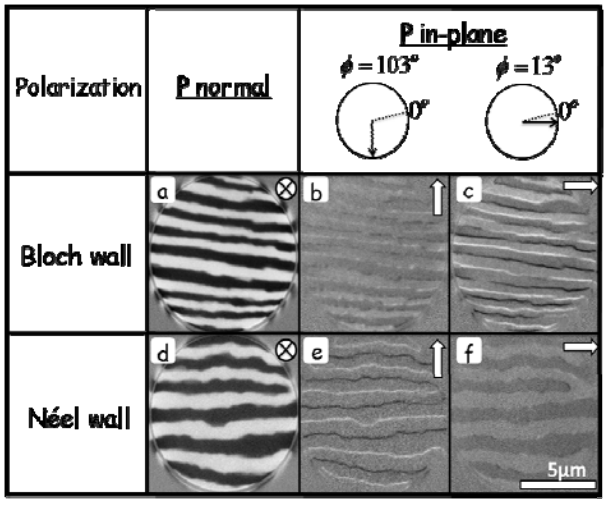

Fig.1, Magnetic stripe domains with (a-c) Bloch-type and (d-e) Néel-type domain wall imaged with different magnetization components in Fe/Ni/Cu(001) system. The arrows show the measured magnetization directions.

The authors acknowledge the support by NSFC and MOST of China, and the support of the National Center for Electron Microscopy, Lawrence Berkeley Lab, which is supported by the U.S. Department of Energy under Contract # DE-AC02-05CH11231.

Implementing the Heisenberg Spin Model with Coupled Cavity Arrays

ZeLiang Xiang and J. Q. You
Phys. Dept., Fudan Univ., Shanghai, People's Republic of China

Abstract

Heisenberg spin model is well known as one of the most important models in condensed matter physics for its wide applications but simple form. However, this model is not so easy to be implemented in experiments. As a promising solution, quantum simulation catches the growing interest recently, and there are many valid schemes being researched in optical lattices, Josephson junction array, and so on. Here, we propose the scheme to simulate the Heisenberg spin model with the coupled cavity array. Our scheme provides a feasible way to realize the Heisenberg spin model within the reach of current experimental technology.

A comparison study of CdTe and CdSe/ZnS quantum dots on photostability under single and two photon excitations in living cells

Abstract

The photostability is an outstanding feature of quantum dots (QDs) used as fluorescence probes in biological staining and cell imaging. To find out the related factors on the QD photostability, the photobleaching of naked CdTe QDs and tBSA coated CdSe/ZnS QDs were comparatively studied in human hepatocellular carcinoma (QGY) cells and human nasopharynx carcinoma (KB) cells with the excitation ways of single photon excitation (SPE) and two photon excitation (TPE). In these two cell lines, the cellular QDs were irradiated by a 405 nm continuous wave laser for SPE or a 800 nm femto-second (fs) laser for TPE via a 60× objective in a microscope, and the QD photobleaching with the irradiation time was found to be fitted by a double exponential model with a fast decay time constant (τ_1) and a slow decay time constant (τ_2). The fast decay plays a dominant role in the bleaching course and thus the τ_1 can be used as a parameter to quantitatively evaluate the QD photostability for the different cases. The TPE could decrease the QD photobleaching as compared to SPE. While the tBSA coated core/shell QDs increases the photostability up to 4-5 times referring to the naked QDs, demonstrating a shielding effect of the QD shell to resist the photobleaching. Therefore, the strategy of using core/shell structured QDs with the TPE model is probably a better combination for cell imaging particularly for those long time monitoring studies.

A microscopic theory is presented for electron cotunneling through quantum dots in the Coulomb blockade regime. Beyond the semiclassic framework of phenomenological models, a fully quantum mechanical solution for cotunneling of electrons through a one-dimensional quantum dot is obtained by using a quantum transmitting boundary method without any fitting parameters. Elastic and inelastic cotunneling conductance is calculated as a function of the energy of the incident electron. The result indicates that the cotunneling conductance exhibits little dependence on the spin configuration of the incident and confined electrons.

Ferroelectric Domain Imaging using Piezoresponse Force Microscope

X. Xiao, X. J. Yang, Y. Lu, W. Wang, Y. Z. Wu

Piezoresponse Force Microscope has proved to be an effective tool to imaging the domain structures of ferroelectric materials and has been applied to probe localized polarization switching. By using PFM, Piezoelectric coefficient can be gotten by applying a drive DC offset at the sample changing from positive to negative. Besides, we can write a signal on the ferroelectric materials by applying a voltage higher than the switching critical point. This manipulation is regarded to be a fundamental means for further investigation of ferroelectric storage device. A lot of improvement is still in need to get better results.

Optimal pulse sequences for qubit coupled to a general environment

Rui Li
Department of physics, fudan university, shanghai, 200433.

Abstract

The decoherence of qubit is a obstacle in quantum information processing, dynamical decoupling through applying pulse sequences to eliminate the qubit-environment coupling can protect qubit coherence has been studied broadly, but pulse sequences could introduce errors to quantum systems, therefore, it is vital to optimize pulse sequences. The first optimal pulse sequences was found by Uhrig in spin-boson model only need n pulses to eliminate qubit-environment coupling to $O(T^{n+1})$ (Phys.Rev.Lett. **98**, 100504 (2007)), while for qubit coupled to a general environment, the optimal pulse sequences was still unknow. In this work, we address this problem by use mast equation approach, our theory coincide with Uhrig's UDD dynamical decoupling scheme.

Deformation of the Fermi surface in the two-dimensional extended t-t' Hubbard model

Hui-Min Chen, Chang-Qin Wu
Department of physics, Fudan University, Shanghai 200433, China

We study the extended t-t' Hubbard model with the nearest neighbor repulsion V on a two-dimensional square lattice. We investigate the competition between the superconductivity and Fermi surface deformation using the variational cluster approach(VCA). The ground state, from an energy point of view, favors the *d*-wave superconducting state with isotropic underlying lattice for V_c. As V is increased, the system undergoes a first order transition from the superconductivity to *d*-wave Fermi surface deformation (*d*FSD) at $V = V_c$. We find that the low-energy features of the density of states obviously changes in the presence of *d*FSD. The spectral weight transfers from low-energy peaks to the local minimum very close to the chemical potential. This behavior can be related to the strong critical fluctuations in the vicinity of metamagnetic transition in the bilayer ruthenate $Sr_3Ru_2O_7$.

Tight-binding treatment of the coupling effect in metallic nanostructures

席斌 051019011

We develop a rather general tight-bind method (TBM) to study the coupling effect between localized electromagnetic fields in periodic metallic nanostructures. The coupling strength, which is defined by the matrix elements of the tight-binding Hamiltonian, is calculated *ab initio* from the field profile of a single unit system and analyzed from the aspect of material property. The validity of the TBM is tested by reproducing the rigorous results obtained by the transfer-matrix method (TMM) in 1D slabs case. The coupling effect between localized surface plasmons in nanoparticles is specially investigated as a simple case. The resonance frequencies of multiple nanoparticles system calculated by TBM are shown to be in good agreement with those obtained from the finite-difference-time-domain (FDTD) simulation. Detailed results show that the distance between nanoparticles and the size of nanoparticles influence the coupling strength between localized surface plasmons. We further show that the frequency position of the “dark mode” can be identified directly using the TBM.

Quantum phase transitions in Kitaev spin models

施小锋

We study the quantum phase transitions in the Kitaev spin models on both honeycomb and Fisher (triangle-honeycomb) lattices. Our analytical results show that the Kitaev spin model on the honeycomb lattice exhibits a continuous quantum phase transition. We also reveal the relationship between bipartite entanglement and the ground-state energy. Our approach directly shows that both the entanglement and the ground-state energy can be used to characterize the topological quantum phase transition in the Kitaev spin model on the honeycomb lattice. Also, we show that the quantum phase transitions can occur in the same topological class for the Kitaev spin model on a Fisher lattice.

Surface ferromagnetism in HfO2 induced by excess oxygen atoms

G. H. Chen[1,2], Q. Zhang[2,3], X. G. Gong[1], and S. Yunoki[2,3]
[1]*Surface Physics Laboratory and Department of Physics, Fudan University, Shanghai 200433, China*
[2]*Computational Condensed Matter Physics Laboratory, RIKEN ASI, Saitama 351-0198, Japan*
[3]*CREST, Japan Science and Technology Agency (JST), Tokyo 102-0075, Japan*

First principles simulations based on density functional theory are performed to study surface magnetic properties of low index cubic, tetragonal, and monoclinic HfO2 surfaces with different terminations. Our systematic calculations reveal that i) stoichiometric surfaces as well as Hf rich non-stoichiometric surfaces are non magnetic, and ii) O rich non-stoichiometric surfaces are ferromagnetic and often half metallic. The ferromagnetism found here is attributed to O surface electronic states with large O 2p spin exchange energy. Our finding provides a novel pathway to d0 ferromagnetism for simple oxides with no magnetic ions involved. We further calculate the surface energy to discuss a possible reason for recent controversial observations of ferromagnetism in HfO2.

Effects of the RGTFEGKF Inhibitor on the Structures of the Transmembrane Fragment 70 86 of Glycophorin A: An All-Atom Molecular Dynamics Study

Huiyu Li, Yin Luo , and Guanghong Wei

Department of physics Fudan University,Shanghai 200433 China

There is experimental evidence that the transmembrane fragment spanning amino acids70—86 of glycophorin-A, GpA70-86, forms amyloid fibrils and the inhibitor RGTFEGKF prevents GpA70-86 fibrilformation at an equimolar ratio. To explore the intrinsic, early interaction and inhibition mechanism ,we have determined the structures of GpA70-86 in the absence and the presence of the inhibitor by means of extensive molecular dynamics simulations in explicit solvent. Consistent with experiments of the fibrils, our simulation show that the inhibitor has a sigmificant impact on the global structure of the GpA70-86.

Extrinsic Anomalous Hall effect in paramagnetic NiCu alloys

Yufan Li*, Li Ye, Yuan Tian, and Xiaofeng Jin

Surface Physics Laboratory and Physics Department, Fudan University, Shanghai, China

The anomalous Hall effect (AHE) is one of the most famous transport phenomena in magnetic materials due to its complicated origins and long debating history. Theoretically, three mechanisms are proposed to explain the origin of AHE: extrinsic skew scattering and side jump, which give $\rho_{sk} \propto \rho_{xx}$ and $\rho_{sj} \propto \rho_{xx}^2$, respectively; and intrinsic anomalous velocity mechanism, which also gives $\rho_{int} \propto \rho_{xx}^2$. Therefore it is a big challenge to separate experimentally the intrinsic from the side jump mechanism, which should be important from both application and fundamental point of views. Paramagnetic material with magnetic element provides a desirable system to study the extrinsic mechanisms of the anomalous Hall effect, for its band structure excludes the intrinsic mechanism. Some pioneering works are carried out by A.Fert in which skew scattering is investigated in some dilute magnetic alloys. In this work, the anomalous Hall effect in paramagnetic Ni-Cu alloy thin films is investigated as a function of temperature. The anomalous Hall resistivity shows strong temperature dependence, which presumably arises from spin flip of magnetic impurities. A liner term, rising from skew scattering, is clearly observed as the film thickness varies systematically. The quadratic term which is conventionally identified as side jump shows strong correlation with skew scattering, suggesting another possible origin as the higher order of skew scattering.

Enhanced broadband infrared emission of erbium–thulium codoped ZnO films with Si Nanocrystals as broadband sensitizers

Xiao Wang[1], Fei Xu[2], Yongliang Fan[1], Mingzhu Li[1], Yu Pu[1], Tianxiao Nie[1], Fang Lu[1] and Zuimin Jiang[1]

1 Surface Physics Laboratory (National Key Laboratory), Fudan University, Shanghai 200433, China

2 SHU-SolarE R&D Lab, Department of Physics, College of Sciences, Shanghai University, Shanghai 200444, China

Abstract

Er Tm Si codoped ZnO bilayer film, consisting of Er-Si-codoped ZnO (Er: Si: ZnO) and Tm-Si-codoped ZnO (Tm: Si: ZnO) layer, has been synthesized by co-sputtering from separated Er, Tm, Si, and Al_2O_3 targets. The dependence of Er^{3+} Tm^{3+} related photoluminescence (PL) properties on annealing temperatures over 800 to 1000 ℃ was studied. A flat and broad emission band in the 1400–1700 nm was achieved, both in the Er-Tm and Er-Tm-Si codoped films. And the observed 1533 and 1800 nm emission bands were attributed to the transitions of Er^{3+}: $_4I^{13/2} \rightarrow {}_4I^{15/2}$ and Tm^{3+}: $_3F^4 \rightarrow {}_3H^6$, respectively. The Tm and Er related photoluminescence (PL) intensities at 1800nm and 1533nm are both enhanced when codoping with Si nanocrystal (Si-NC) as broadband sensitizer thus suggesting the existence of multiple energy transfer processes from Si-NC to Er and Er to Tm in ZnO film.

A Simple Agent-based Model: modeling the motion of stock price

Jianrong Wei and Jiping Huang
Phys. Dept., Fudan Univ., Shanghai, People's Republic of China

Empirical studies of stock price have shown a lot of stylized facts, such as fat tail behavior of the distribution of stock return, the power law form of the fat tail, and the Hurst exponent behavior . Here we try to build a simple agent-based model to simulate the motion of stock price, and reproduce those well-known stylized facts. Our model is based on three hypotheses, including herding effect, which is an important phenomena in real market. Further study , like considering the Hurst exponent behavior and autocorrelation property, will be done in our model.

Nontrivial Bloch oscillations in photonic lattices with second-order couplings

G. Wang[1], J. P. Huang[1] and K. W. Yu[2]
[1]*Department of physics, Fudan University, Shanghai 200433, China*
[2]*Department of Physics, Chinese University of Hong Kong, Hong Kong*

Under the influence of the next-nearest-neighbor interactions, we investigate the occurrence of Bloch oscillations in zigzag waveguide arrays (one kind of accessible and widely-used realization of photonic lattices model). Because of the special topological configuration of the lattice itself, the second-order coupling can be enhanced significantly and leads to the band alternation beyond the nearest-neighbor model, i.e., the offset of minimum value from the Brillouin zone edge. Contrary to the typical results [2], the oscillation patterns exhibit new features, namely, a double turning-back occurs when the beam is approaching the zone edge. Our results can be applied to some ordered lattices systems [3].

References:

1. G. Wang, J. P. Huang, and K. W. Yu, Opt. Lett. (Accepted).
2. T. Pertsch, P. Dannberg, W. Elflein, A. Brauer, and F. Lederer, Phys. Rev. Lett. 8**3**, 4752 (1999).
3. M. Ben Dahan, E. Peik, J. Reichel, Y. Castin, and C. Salomon, Phys. Rev. Lett. 76, 4508 (1996).