ÚJ SZÉCHENYI TERV

MAGYARORSZÁG MEGÚJUL

A projekt az Európai Unió támogatásával, az Európai Szociális Alap társfinanszírozásával valósul meg.

PhD Conference of the Doctoral School for Physics

Faculty of Natural Sciences

Budapest University of Technology and Economics,

The conference is organized in the framework of ***TÁMOP-4.2.2/B-10/1-2010-0009***

Friday, 22 June 2012

ABSTRACTS

PLENARY SESSION

Atmospheric interface design for mass spectrometry

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Mass spectrometry offers a quick, highly sensitive and accurate method for identifying ionized samples, both organic and non-organic. On the other hand, the need for high vacuum of the analyzers limits the area of possible applications. The devices that transport ions or charged particles into high vacuum regions from low vacuum, or even from atmospheric conditions are called atmospheric interfaces. With those devices the sampling capabilities of mass spectrometers can be extended into atmospheric regions, and the advantages of the mass spectrometry can be utilized in several different areas, such as food safety, healthcare, drugs/explosives detection, etc. The transportation efficiency of an atmospheric interface limits the sensitivity of the mass spectrometer, and our ongoing project aims the improvement of such devices.

The connection between tightly focused beams and the concentration problem on the sphere

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By solving the so-called concentration problem on the sphere for vector fields, new vector basis functions, the vector Slepian harmonics (VSLHs) are proposed to approximate the plane wave amplitude spectrum of the focused field of a high numerical aperture (NA) focusing system. A subset of the VSLHs exhibits excellent

energy concentration to the solid angle of illumination. The VSLHs could be useful in other fields of physics as well.

Theoretical study of magnetic domain walls through a cobalt nanocontact

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To calculate the magnetic ground state of nanoparticles we present a self-consistent first principles method in terms of a fully relativistic embedded cluster multiple scattering Green's function technique. Based on the derivatives of the band energy, a Newton-Raphson algorithm is used to find the ground state configuration. The method is applied to a cobalt nanocontact that turned out to show a cycloidal domain wall configuration between oppositely magnetized leads. We found that a wall of cycloidal spin-structure is about 30 meV lower in energy than the one of helical spin-structure. A detailed analysis revealed that the uniaxial on-site anisotropy of the central atom is mainly responsible to this energy difference.

Magnetic perturbation induced transport in fusion plasmas

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Nuclear fusion in tokamaks is a promising future energy production mechanism. Some of the still unsolved problems are connected to the effect of magnetic perturbations on the plasma transport. Even as small as 0.1% relative perturbation can lead to several orders of magnitude change in the transport. This is a deleterious effect when plasma confinement is the goal, however, this phenomenon can be used to remove unwanted particles from the plasma by applying externally generated magnetic perturbations. In this paper we introduce the general idea of the phenomenon and present an example application.

Global Superfluid and Magnetic Phase Diagram of a Three-component Fermion Mixture

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In this work I investigate the global phase diagram of a three-component fermion mixture in the presence of weak attractive interactions, using a combination of equation of motion and Gaussian variational mean field approaches. These techniques allow for treating the superfluid and magnetic ordering in an unbiased way, and capture the interplay between the two order parameters. In the close vicinity of the critical temperature and for small chemical potential differences, strong particle-hole symmetry breaking leads to a phase diagram similar to the one predicted by Cherng et al. [Phys. Rev. Lett. **99**, 130406 (2007)], however, the overall phase diagram is markedly different. We find new chemical potential-driven first and second order transitions and triple points.

SESSION A (ATOMIC PHYSICS)

Surface analytical investigation of Ti maxillofacial miniplates retrieved from the human body

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Although surface analytical methods are versatile tools in the study of problems related to material science and surface properties, they are not used widely for the investigation of implant materials. In the present work surface analytical methods are applied to study anodically and thermally oxidised Ti miniplates used in maxillofacial surgery for osteosynthesis. Plates right after oxidation, after oxidation and sterilization and plates retrieved from the human body after 9 and 13 months were investigated. According to our results the oxide layer on the surface of all the miniplates is constituted of TiO_2 and the thickness of the layers does not change during the sterilization or the time spent in the human body. The results suggest that the oxide layer formed with anodic and thermal oxidation does not decompose in the harsh environment of the human body.

Polarized light extraction from light emitting diodes by means of metallic nanostructures

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We investigate metallic nanostructures to obtain polarized light extraction from light emitting diodes. Surface structures of periodic arrays of metallic wires are used as polarization selective filters and polarization recycling surfaces. We use rigorous electromagnetic calculations and ray tracing in conjunction to model a complete LED source. Extinction ratio over 70 is obtained with extraction efficiency more than the half of an unpolarized LED source. Besides the wire grid polarizer the scattering and absorption properties of metallic nanoellpisoids are studied with the quasistatic approach and the finite element method. Polarization dependence in the scattering and absorption cross section are cleraly visible which indicates that these nanostructures are good candidates for the use in polarization selective devices.

Nanocrystal solar cells and impact ionization in silicon nanocrystals

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Multiple Exciton Generation (MEG) in semiconductor nanocrystals (NCs) is considered to be a promising path to improve the efficiency of solar energy conversion. Recent experimental and theoretical studies indicate that MEG is more efficient in NPs than in the bulk only on a relative energy scale in units of the gap. The primary cause of this is that quantum confinement increases the energy gap substantially in NPs. MEG will realize its promise for photovoltaics when NCs are identified whose impact ionization rate is enhanced even on the absolute energy scale. To contribute to the search for such NCs, we studied the MEG process in silicon NCs using density functional theory, treating the Coulomb interaction via a static screening form within the random-phase approximation. We calculated the impact ionization rates for the Si NPs with diameters up to the experimentally relevant size of 2 nm. Our calculations explicitly tracked the effects of the quantum confinement.

Measurement method for the examination of the polarization properties of low-birefringence optical materials

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We worked out a measurement method for spectroscopic ellipsometer which makes it possible to determine birefringence properties of optical quality polymers. We modified the conventional ellipsometric measurement in accordance with our theoretical calculations made for polarized light passing through birefringent media. The acquired ellipsometric signals are analyzed by MATLAB routines which are able to determine the direction of the semi-major axis of the projection of the polarization ellipsoid perpendicular to the optical axis of the ellipsometer and the shape of the projected ellipse. We tested the reliability of our method on a first order $\lambda/4$ filter. The first application of the method is also published here which is the comparison of two low-birefringence optical polymer samples. In this later investigation we made measurements at several positions on our planar samples to see how the mechanical stress changes in such injection molded components.

SESSION B (NUCLEAR TECHNIQUES)

Micro-XRF studies on biological samples using synchrotron radiation

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Environmental events strongly influence biological systems through metabolic processes in sensitive biological species. The uptake, transport and accumulation effects of different compounds within biological systems are currently in the focus of intensive biochemical research. These compounds enter to the food chain therefore it has a strong influence on the human health. Cucumber hypocotyls were studied by micro-X-ray fluorescence confocal imaging technique at HASYLAB Beamline L to determine the distribution of the toxic elements within the plant object. Confocal geometrical setup was used with around 20μm lateral resolution. The distribution of the elements was calculated from their fluorescent lines intensity with FPM based algorithm.

Beam Emission Spectroscopy Measurements on KSTAR

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Beam emission spectroscopy (BES) is a powerful technique to measure density and fluctuations via observing visible light emission from an atomic beam [1]. After promising modelling results, a trial BES system was designed and installed during 2011 on the KSTAR tokamak (Korea Superconducting Tokamak Advanced Research, Daejon, South-Korea) for showing the feasibility of this measurement technique on KSTAR. The diagnostic measures the light emission from the heating neutral beam. The setup allows measurement of plasma fluctuations on the plasma edge, which is suitable for edge turbulence and ELM (Edge Localised Mode) precursor analysis.

Photron FASTCAM SA5 control software development for fusion plasma measurements

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A new control software Phot_control has been developed for Photron FASTCAM SA5 high speed camera to simplify the pellet ablation measurements on ASDEX Upgrade tokamak. Phot_control is a based on the Photron Software Development Kit

and the KAKADU software, and it is written in C++. The program controls the most important camera parameters fitted to the pellet monitoring system, keeping meanwhile a high level of transportability. The output data are stored in 12bit mj2 video file format, as well as ASCII Log files for metadata, which helps further data processing. Phot_control was successfully tested in laboratory environment and also during real plasma discharges.

Development of an enhanced atomic beam diagnostic for the COMPASS tokamak

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Lithium diagnostic beams are used mainly for density and density fluctuation measurements in fusion plasma devices. This method is called Beam Emission Spectroscopy (BES), and it works by detecting the light emitted by the lithium beam when it interacts with the plasma. However, the beam atoms eventually get ionized, and move under the influence of the magnetic field afterward. With sufficiently high beam energies and proper placement of a detector, it is possible to capture these ions, and design a different lithium based beam diagnostic. These ions carry information about the density, just like with the BES method, and about the magnetic field. The aim of this paper is to show the concept of this detection method and its future possibilities with magnetic field reconstruction.