18th Conference of Czech and Slovak Physicists
with participation of Hungarian and Polish Physical Societies
Olomouc, Czech Republic, September 16–19, 2014

Conference programme

Monday 15/9/2014

16.00–19.00 **Registration**
Faculty of Science, 17. listopadu 1192/12, Olomouc
Registration and info will be available during all conference days (on Tuesday 16/9 in the morning at the Archbishop palace)

Tuesday 16/9/2014

Archbishop palace hall, Wurmova 9, Olomouc

Official opening

9.00–9.30 **Welcome greetings**
Miroslav Mašláň (vice-rector of the Palacký University)
Jan Mlynář (president of the Czech Physical Society)
David Lee (EPS secretary general)
Libor Machala (chair of the local organizing committee)

9.30–9.45 **Milan Odehnal and Slovak Physical Society prizes ceremony**

Laureates presentations (chair Dalibor Krupa)

9.45–10.00 *Jana Čisárová et al.*
Quantum and cooperative phenomena in exactly solvable lattice-statistical models on TIT lattices

10.00–10.15 *Lucia Gálisová*
Ground state, magnetization process and magnetocaloric effect of the exactly solvable Ising-Heisenberg model with the diamond chain geometry

10.15–10.30 *Juraj Feilhauer, Martin Moško*
Ballistic persistent currents in disordered metallic rings: Origin of puzzling experimental values

10.30–10.45 *Karol Vegso et al.*
Studies of nanoparticle Langmuir films by GISAXS method

10.45–11.00 *Bohumil Stoklasa et al.*
Tomographic methods in modern optics

11.00–11.30 COFFEE BREAK ☕

Laureates presentations (chair Jan Mlynář)

11.30–11.45 *Martina Miková et al.*
Experimental Realization of Quantum Information Processing

11.45–12.00 *Pavol Federič*
Study of charge of top quark in experiment ATLAS

12.00–12.15 *Jiří Kaštil*
Magnetocaloric effect of selected rare-earth materials

12.15–12.30 *Vítězslav Jarý, Eva Mihóková, Martin Nikl*
Thermally induced ionization and quenching processes in novel oxide and sulfide scintillation materials

12.30–12.45 *Lucie Augustovičová et al.*
Depopulation of metastable helium by radiative association in interstellar environment

12.45–13.00 *Martin Kozák*
Time-resolved study of exciton and electron-hole liquid dynamics in diamond

13.00–14.30 TIME FOR LUNCH (and to move to the Faculty of Science)

Faculty of Science, 17. listopadu 1192/12, Olomouc

Invited lecture (chair Marian Reiffers, room 2.001)

14.30–15.20 *John Dudley*
Nonlinear optics

15.20–15.50 COFFEE BREAK ☕

FAIR, HADES parallel session (chair Andrej Kugler, room 2.004)

15.50–16.20 *Karl-Heinz Langanke*
Introduction to FAIR, an international facility for research with antiprotons and ions

16.20–16.30 *Radek Pleskač*
BIOMAT: Experimental Facility for Biophysics and Material Science at FAIR

16.30–16.40 *Andrej Kugler*
Czech participation in FAIR
16.40–16.50 *Eberhard Widmann*
Austrian participation in FAIR
16.50–17:00 *Gyorgy Wolf*
Hungarian participation in FAIR
17.00–17.15 **Discussion**
17.15–17.30 *Ondřej Svoboda et al.*
Electromagnetic calorimeter for the HADES spectrometer
17.30–17.45 *Vasily Mikhaylov et al.*
Anisotropic flow and the reaction plane reconstruction with the CBM experiment
17.45–18.00 *Lukáš Chlad*
Secondary pion beam for HADES experiment at GSI
18.00–18.15 *Ramos Rodríguez*
Preliminary results of pion induced reaction with carbon and polyethylene targets obtained by HADES-GSI in 2014
18.15–18.30 *Miroslav Šimko*
Simulations for the HFT-Pixel detector at the STAR experiment

Plasma physics and lasers parallel session (chair Jan Soubusta, room 2.001)

15.50–16.10 *Jan Mlynář, Viktor Loffelmann*
On a possibility to combine plasma tomography with unfolding of energy spectra in fusion research
16.10–16.40 *Radomír Pánek and the COMPASS team*
Status of the COMPASS tokamak and recent results
16.40–17.00 *Hana Turčičová et al.*
Development of high-repetition rate lasers in HiLASE project

Magnetism and low temperatures parallel session (chair Jiří J. Mareš, room 2.005)

15.50–16.10 *Marian Reiffers et al.*
Properties of UFeSb2 uranium antimonide
16.10–16.25 *Illa Ramakanth et al.*
Structural and optical properties of Manganese ferrite thin films fabricated using modified sol-gel method
16.25–16.40 *Marcel Človečko et al.*
Probing surface bound states in superfluid 3He-B by mechanical resonators
16.40–16.55 *František Vavrek et al.*
Quartz tuning fork as a high Q-value resonator – its vacuum properties in high magnetic field up to 8 tesla and at mK temperatures

17.00 **Physical societies representatives meeting (invited participants only)**

Wednesday 17/9/2014

Faculty of Science, 17. listopadu 1192/12, Olomouc

Invited lectures (chair Alice Valkárová, room 2.001)

9.00–9.50 *Józef Spałek*
Strongly correlated quantum matter: unusual quasiparticles and real space pairing

9.50–10.40 *Rupert Leitner*
Discovery of a Higgs boson at CERN

10.40–11.10 COFFEE BREAK ☕

Invited lecture (chair Alice Valkárová, room 2.001)

11.10–12.00 *Karol Hricovini*
Novel Materials for Energy and Spintronics Applications

12.00–13.30 TIME FOR LUNCH

Invited lectures (chair Eduard Hulicius, room 2.001)

13.30–14.20 *Peter Kopčanský*
Feronematics

14.20–15.10 *Jiří J. Mareš*
The concept of temperature – critical analysis

15.10–15.50 COFFEE BREAK ☕

Materials parallel session (chair Jiří Erhart, room 2.001)

15.50–16.05 *Štefan Lányi, Vojtech Nádaždy*
A scanning charge-transient microscope

16.05–16.20 *Martin Liščinský, Michal Géci, Mária Šviková*
Melting Behavior of Two-Dimensional Air-Driven System of Small Magnets

16.20–16.40 *Vlastimil Vrba, Vít Procházka, Marcel Miglierini*
Metallic glasses crystallization by nuclear forward scattering of synchrotron radiation

16.40–17.05 *Tomáš Opatrný*
Spin squeezing

Education and biophysics session (chair Roman Kubínek, room 2.005)

15.50–16.05 *Viera Haverlíková, Ivan Haverlík*
Barriers of using models and modeling in medical biophysics education

16.05–16.20 *Viera Haverlíková*
Development of children's modelling skills through non-formal activities

16.20–16.35 *Ivan Melo*
Cascade projects competition for high school students

16.35–17.05 *Adam Gadomski, Roland Winkler*
Addressing nanoscale soft-matter problems by computational physics and physical computation

17.15–19.00 Guided tour through the city center (starts at the Faculty of Science, ends at St. Wenceslaus & microbrewery)

Thursday 18/9/2014

Faculty of Science, 17. listopadu 1192/12, Olomouc

Invited lectures (chair Libor Machala, room 2.001)

9.00–9.50 *Sándor Katz*
The phase diagram of Quantum Chromodynamics

9.50–10.40 *Szabolcs Csonka*
Quantumelectronics, an emerging field at the nanoscale

10.40–11.10 COFFEE BREAK ☕

Invited lecture (chair Libor Machala, room 2.001)

11.10–12.00 *Richard Hlubina*
Current problems in physics of high-temperature superconductors

12.00–13.30 TIME FOR LUNCH

13.30–14.30 POSTER SESSION (2nd floor)

Heavy ion parallel session (chair Ladislav Šándor, room 2.001)

14.30–14.50 *Pavol Federič*
Open heavy flavor measurements at STAR

14.50–15.10 *Filip Křížek*
Study of high-p_T hadron-jet correlations in ALICE

15.10–15.30 *Jan Rusňák*
Charged jet reconstruction in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV at RHIC

15.30–15.45 *Ivan Melo, Boris Tomášik*
Transverse momentum spectra fits in Pb+Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV

Particle physics parallel session (chair Eva Šimečková, room 2.005)

14.30–14.55 *Daniel Červenkov*
Study of CP Violation and Physics Beyond the Standard Model at the Belle experiment

14.55–15.15 *Jaroslav Dittrich, Philippe Briet, Eric Soccorsi*
Scattering through a straight quantum waveguide with combined boundary conditions

15.15–15.30 *Michaela Mlynáriková*
Investigation of the Higgs boson properties

15.30–15.45 *Michal Vajzer*
Study of jet properties in pp collisions at 7 TeV and pPb collisions at 5.02 TeV using POWHEG-Box

15.45–16.15 COFFEE BREAK ☕

Heavy ion and quark gluon plasma parallel session (chair Radek Pleskač, room 2.001)

16.15–16.30 *Ladislav Šándor*
Strangeness enhancements in heavy-ion collisions from SPS to LHC

16.30–16.55 *Pavol Štefko*
Study of jet quenching in heavy ion collisions at LHC using ATLAS detector

16.55–17.15 *Barbara Trzeciak and STAR Collaboration*
J/psi measurements in STAR

17.15–17.35 *Jana Crkovská et al.*
Influence of resonance decays on triangular flow in relativistic heavy-ion collisions

17.35–18.00 *Michal Křelina, Jan Nemchik*
Nuclear effects in nucleon–nucleus collisions and nucleus-nucleus collisions

18.00–18.15 *Zuzana Fecková, Boris Tomášik*
Ideal hydrodynamic modeling of quark-gluon plasma

Parallel session (chair Miroslav Hrabovský, room 2.005)

16.15–16.35 *Eva Šimečková et al.*
The NPI Center of Accelerators and Nuclear Analytical Methods (CANAM), Basic and Applied Research with Ion Beams

16.35–16.55 *Milan Štefánik et al.*
Center of Accelerators and Nuclear Analytical Methods (CANAM): Fast Neutron Generators

16.55–17.25 *Adam Gadomski, Jan Klos*
Recognizing an applied-physics and physicochemial succession of Jan Czochralski, a prominent European crystal grower

19.00–24.00 Conference party (Faculty of Science, 6th floor)

Friday 19/9/2014

Faculty of Science, 17. listopadu 1192/12, Olomouc

Invited lectures and plenary information (chair Jaroslav Dittrich, room 2.001)

9.00–9.30 *Karel Šafařík, Ladislav Šándor*
60 years of CERN

9.30–9.50 *Martin Černohorský*
54th Academic Forum "The new strategy of the Academy of Sciences of the Czech Republic", Prague, September 18, 2014

9.50–10.40 *Radek Zbořil*
Advanced nanoarchitecture of iron and iron oxide based materials for environmental, catalytic and biomedical applications

10.40–11.10 COFFEE BREAK ☕

Invited lecture and plenary information (chair Jaroslav Dittrich, room 2.001)

11.10–12.00 *Jan Soubusta*
Experimental quantum information processing with linear optics

12,00–12.30 *Zsolt Fülöp*
Activities in EPS

12.30 CLOSING SPEECH/LUNCH

Invited speakers

Quantumelectronics, an emerging field at the nanoscale

Szabolcs Csonka (Budapest University of Technology and Economics)

Szabolcs Csonka is an assistant professor at the Budapest University of Technology and Economics, a member of the solid state physics laboratory. His main research interests is nanophysics, particularly quantum effects in nanostructures, hybrid nanostructures, semiconductor nanowires, the spin transport, quantum dots, superconducting correlations, atomic and molecular junctions, transport through single metal atoms, simple molecules, point contact spectroscopy and Andreev spectroscopy.

Nonlinear optics

John M. Dudley (University of Franche-Comté, Besançon, France)

Originally from South Auckland in New Zealand, John Dudley received B.Sc and Ph.D. degrees from the University of Auckland in 1987 and 1992 respectively. In 1992 and 1993, he carried out postdoctoral research at the University of St Andrews in Scotland before taking a lecturing position in 1994 at the University of Auckland. In 2000, he was appointed Professor at the University of Franche-Comte in Besancon, France, where he heads the Optoelectronics and Photonics research group that currently consists of around 12 permanent staff and 20 contractual staff and/or graduate students. His research interests cover broad themes in nonlinear and ultrafast optics, and he is currently co-laureate of an European Research Council Advanced Grant with Professor Frederic Dias of UCD Dublin to study the physics of extreme waves in optics and hydrodynamics. He was named a member of the Institut Universitaire de France in 2005 and elected a Fellow of the Optical Society of America in 2007. He was an IEEE LEOS Distinguished Lecturer for the period 2008–2010 and is Past Chair of the Quantum Electronics and Optics Division of the European Physical Society. In 2009, he was awarded the Grand Prix de l'Electronique Général Ferrié from the Société des Electriciens et Electroniciens (SEE) and has also received a research award from the IXCORE Foundation. He is currently a Deputy Editor of the OSA journal Optics Express, and he participates in OSA and SPIE Travelling Lecturer programmes. He was elected as a Fellow of the IEEE in 2011 and a Fellow of the European Optical Society in 2012. In 2012 he was elected Vice President of the European Physical Society, and he is serving as its President from April 2013.

Activities in EPS

Zsolt Fülöp (Inst. of Nuclear Research of HAS, Debrecen)

Zsolt Fülöp is the director of MTA Atomki, Institute for Nuclear Research in Debrecen, Hungary. His main interest is nuclear astrophysics, including underground nuclear physics, the astrophysical p-process and exotic nuclei. He was the chair of the Nuclear Physics Division of the EPS between 2010–11. At present, he is serving at the Executive Committee of the European Physical Society and member of Academia Europea.

Current problems in physics of high-temperature superconductors

Richard Hlubina (Comenius University, Bratislava)

Richard Hlubina is an associate professor at the Dept. of Experimental Physics of the Faculty of Mathematics, Physics and Informatics at Comenius University in Bratislava. His main interests include condensed matter theory, strongly correlated electron systems and unconventional superconductivity.

Novel Materials for Energy and Spintronics Applications

Karol Hricovini (Université de Cergy-Pontoise)

Karol Hricovini is a professor at the University of Cergy-Pontoise, Paris region, and director of the Laboratoire de Physique des Matériaux et des Surfaces. His research activity includes electronic structure and magnetism of solids studied by photoemission and other photon-based spectroscopies using synchrotron radiation.

The phase diagram of Quantum Chromodynamics

Sándor Katz (Eötvös Loránd University, Budapest)

Sándor Katz is a professor at Eötvös University, currently the head of the Institute of Theoretical Physics. He obtained his Ph.D. in 2001 at the Eötvös University. He was a postdoctoral researcher at DESY, Hamburg, and at the University of Wuppertal, Germany. Since 2008 he has been the leader of the Lattice Gauge Theory group at the Eötvös University. His main research interests are various areas of lattice QCD: the determination and properties of the phase diagram at finite chemical potential or external magnetic field, the QCD hadron spectrum, nuclear physics from lattice QCD.

Feronematics

Peter Kopčanský (Inst. of Experimental Physics SAS, Košice)

Peter Kopčanský is a research professor at the Institute of Experimental Physics Slovak Aca-de-my of Sciences at Košice and a head of Centre of excellence named Nanofluid responsible for implementation of projects of structural funds of European Union into infrastructure and education in field of nanotechnology. He is a member of International steering committe of magnetic fluids since 2004 and received an award of Slovak Academy of Sciences for his work in the field of magnetic drug targeting in 2007. His main interests include the study of magnetoviscosity of magnetic fluids, magnetodielelectric and magnetooptical properties of magnetic fluids, radiation stability of magnetic fluids, study of composite systems of liquid crystals with magnetic fluids (called ferronematics), magnetic drug targeting, interaction of magnetic particles with a myloid structures.

Discovery of a Higgs boson at CERN

Rupert Leitner (Charles University, Prague)

Rupert Leitner is associate professor of particle physics at the Charles University in Prague. He is reading lectures on nuclear and particle physics and experimental foundations of the Standard Model. He supervised several bachelor, diploma and PhD thesis. Currently he is involved in the experiment ATLAS at CERN Large Hadron Collider, he was leading (2001–2005) the project of ATLAS hadron calorimeter TileCal. He is also member of international neutrino experiment Daya Bay. He is author and co-author of many scientific papers; he has served in various committees, in particular High Energy and Particle Physics committee of the EPS (2004–2012) and was part of Organizing Committees of various particle physics conferences and Schools.

The concept of temperature – critical analysis
Jiří J. Mareš (Inst. of Physics AS CR, Praha)

Jiří J. Mareš is a Deputy Director of the Institute of Physics, Academy of Sciences of CR specialized in condensed matter physics. He deals with quantum transport properties of semiconductor-based disordered systems and with fundamental problems of thermal physics and electrostatics.

Experimental quantum information processing with linear optics
Jan Soubusta (Palacký University, Olomouc & Inst. of Physics AS CR, v.v.i., Praha)
Jan Soubusta is an associated professor of optics and optoelectronics at the Joint Laboratory of Optics at Palacký University in Olomouc since 2010. He graduated in 2000 at the Faculty of Mathematics and Physics, Charles University in Prague, where he was studying optical properties of 2D quantum heterostructures. Recently he is working in the field of nonlinear optics, quantum optics and quantum information processing with light. He is a leader of quantum information processing laboratory at the Joint Laboratory of Optics. His main research interests are quantum cloning experiments, experimental quantum information processing, implementing theoretical proposals, building quantum optics gates and filters and studying new sources of correlated photons based on periodically poled materials.

Strongly correlated quantum matter: unusual quasiparticles and real space pairing
Józef Spałek (Jagiellonian University, Krakow)

Prof. Jozef Spałek is the Head of the Department of Condensed Matter Theory and Nanophysics in the Institute of Physics of the Jagiellonian University, and also professor at the AGH University of Science and Technology, both in Kraków. His postdoctoral work was carried out in England (Imperial College of Science, Technology, and Medicine), in USA (Purdue University), and in France (CNRS, Universite Paris-Sud, and Universite Paris-Nord). He was also a visiting professor at Purdue University, visiting scholar at Harvard University, and professor at Warsaw University (1991–1998). His research interests are concentrated on quantum materials with strongly correlated electrons and in particular, on theory of high temperature ad heavy-fermion superconductivity. He is also interested in nanophysics. In both topics he proposed a new theoretical approach taking into account the strong correlations among the electrons. Recently, he has become interested also in the subject of emergent phenomena in Nature and related philosophical questions. For his work he was awarded the Maria Skłodowska-Curie Prize of the Polish Academy of Sciences and a special fellowship from the Foundation for Polish Science in the years 2003–2007. He is a foreign member of Accademia di Scienze e Lettere based in Milano. In 2005, Professor Spałek received the Polish Order of Merit, the Polonia Restituta Cross from the President of Poland. He was also awarded the Alessandro Volta Silver Medal by Universita di Pavia for his work for the School "European Doctorate in Physics". In the period 2004-10 he was a member of the Science Council to the Minister of Science and Higher Education.

Advanced nanoarchitecture of iron and iron oxide based materials for environmental, catalytic and biomedical applications

Radek Zbořil (Palacký University, Olomouc)

Radek Zbořil is a professor at the Palacky University in Olomouc and the general director for the Regional Centre of Advanced Technologies and Materials in Olomouc. He is also an active member on the board of Technology Agency of the Czech Republic. In 2011, he was awarded by the Czech Republic Minister of Education for extraordinary results achieved in the field of research, experimental development and innovations. Professor Zbořil is author and co-author of more than 200 papers in top international journals including Chemical Reviews, ACS Nano, Journal of the American Chemical Society, Chemistry of Materials, Biomaterials, Small or Advanced Functional Materials etc. His specialization includes nanomaterial research – iron and iron oxide based nanoparticles, silver nanoparticles, carbon nanostructures (graphene derivatives, carbon dots), and magnetic nanoparticles. These materials have multiple applications in catalysis, water treatment, antimicrobial treatment, medicine and biotechnologies.

Talks

Depopulation of Metastable Helium by Radiative Association in Interstellar Environment

Lucie Augustovičová, Wolfgang. P. Kraemer, Vladimír Špirko, Pavel Soldán

Radiative association is an important process of formation of molecular ions/molecules in interstellar space. Radiation due to spontaneous radiative processes has important astrophysical implications, since metastable atomic states provide most of the light emitted from planetary nebulae. Due to the relatively large amount of helium in interstellar space, we investigated the depopulation of the metastable levels of He(2^3S), having a unusually long lifetime [1], and He(2^1S) by radiative collisions with hydrogen, helium and lithium ions [2,3,4]. Through the process of radiative association these collisions result in the formation of molecular cations HeH^+ and $LiHe^+$, either in singlet or high-spin electronic state, and He_2^+ in doublet electronic states. Energy dependent cross-sections for spontaneous and stimulated processes on a particular spin manifold are calculated using a fully quantal approach and considering the association to rotational-vibrational states of the lowest electronic states from the initial continuum states: He(2^3S) + $A^+ \rightarrow HeA^+$ or He(2^1S) + $A^+ \rightarrow HeA^+$, where A = H or Li; He(2^3S) + $He^+ \rightarrow He_2^+$ or He(2^1S) + $He^+ \rightarrow He_2^+$. Evaluation of the cross-sections is based on highly accurate quantum calculations taking into account all possible state-to-state transitions at thermal energies (for spontaneous association) or at higher background temperatures (stimulated association). The corresponding rate coefficients are presented as function of temperature. A noticeable effect on the radiative association by black-body background radiation is only obtained for the one state process. References: [1] S. S. Hodgman et al., Metastable Helium: A New Determination of the Longest Atomic Excited-State Lifetime, *Phys. Rev. Lett.* **103**, 053002 (2009). [2] L. Augustovičová, W. P. Kraemer, and P. Soldán, Depopulation of metastable helium by radiative association with hydrogen and lithium ions. *Astrophys. J.* **782**, 46 (2014). [3] L. Augustovičová, W. P. Kraemer, and P. Soldán, Depopulation of metastable helium He(21S) by radiative association with hydrogen and lithium cations, *J. Quant. Spec. Rad. Transf.* **148**, 27 (2014). [4] L. Augustovičová, W. P. Kraemer, V. Špirko, and P. Soldán, The role of molecular quadrupole transitions in the depopulation of metastable helium. (2014), submitted to *Mon. Not. R. Astr. Soc.*

Influence of resonance decays on triangular flow in relativistic heavy-ion collisions

Jana Crkovská et al.

Anisotropic flow in relativistic collisions of heavy-ions yields important information about the state of the hot and dense matter created in the collision. Study of triangular flow in Pb+Pb collisions at LHC was performed using HYDJET++ Monte Carlo generator. HYDJET++ combines both hydrodynamics-driven soft part together with hard jet-part, giving a realistic prediction for vast number of hadron species. The model also enables study of influence of final-state interactions on flow of created hadrons. Triangular flow patterns of pions, kaons and protons were studied. We found that resonance decays influence significantly the shape of the distributions.

54th Academic Forum "The new strategy of the Academy of Sciences of the Czech Republic", Prague, September 18, 2014

Martin Černohorský

A short report on the seminar just held one day before with the lecture given by the president of the Academy of Sciences Prof. Jiří Drahoš. A topic of minor importance while most probably absolutely unrealizable – the project of an international transdisciplinary University for the Future "Krumlovia" – may be mentioned, too.

Study of CP Violation and Physics Beyond the Standard Model at the Belle experiment

Daniel Červenkov

The two B-factories – KEKB/Belle in Japan and PEP-II/BaBar in the USA – surpassed expectations regarding physics results. In 2001 they observed large asymmetries in B meson decays, that were consistent with the theoretical proposal of CP violation mechanism by Kobayashi and Maskawa. This experimental result was explicitly recognized in the 2008 Nobel Prize in Physics speeches of Profs. Kobayashi and Maskawa. The B-factories collected immense amount of data not just on CP violation, but also on B and charm physics, properties of tau leptons, hadron spectroscopy and two-photon physics. Perhaps even more importantly, they found a few hints of potential discrepancies between the Standard Model and experimental data, which might be a tantalizing trace of Physics Beyond the Standard Model. It is apparent that for many of these measurements statistics is the main limiting factor. This has been the key motivation for the ongoing upgrade of both the KEKB accelerator and the Belle detector, that will lead up to the first SuperB-factory (SuperKEKB/Belle II). The talk will try to present the formalism of CP violation within the quark model in an accessible manner. Furthermore, it will explain the techniques used in the B-factories and inform the audience about Czech participation in Belle and Belle II.

Quantum and cooperative phenomena in exactly solvable lattice-statistical models on TIT lattices

Jana Čisárová, Jozef Strečka, Frederic Mila, Frederic Michaud

Classical-quantum Ising-Heisenberg and fully quantum Heisenberg models defined on two planar lattices with "triangles-in-triangles" (TIT) structure are studied exactly. The main focus has been concentrated on investigating a mutual competition between the spin frustration and local or global quantum fluctuations on the ground state, critical behavior and magnetization process of the studied models. The ground state of the Ising-Heisenberg model in the absence of magnetic field displays except of the classical phases also unconventional partially ordered and partially disordered state, which emerges as a consequence of a quantum order-from-disorder effect. This state manifests itself through a quantum reduction of spontaneous magnetization of Heisenberg spins that indirectly causes a small quantum reduction of otherwise classical Ising spins as well. The Ising-Heisenberg model in external magnetic field displays in the ground state besides the classical phases also remarkable quantum phases, which manifest themselves through interesting magnetization curves with two up to four intermediate magnetization plateaus of quantum or classical nature. A remarkable agreement between the magnetization process of the hybrid Ising-Heisenberg model and the magnetization process of the quantum Heisenberg model enables some insight into the ground states of the Heisenberg model from the corresponding exact ground states of the Ising-Heisenberg model.

Probing surface bound states in superfluid 3He-B by mechanical resonators

Marcel Člověčko, Martin Kupka, Maroš Skyba, Peter Skyba, František Vavrek

During the phase transition of liquid ^{3}He to the superfluid state the orbital, the spin and the gauge symmetries are spontaneously broken in a close analogy to spontaneous broken symmetries of early stages of our Universe. Hence the superfluid ^{3}He can serve as a model system for cosmology and particle physics. Below transition temperature T_C the Cooper pairs are formed and superfluid state can be described by a complex order parameter. Due to this a few superfluid phases (A, B, etc.) are observed. In particular, superfluid ^{3}He-B has isotropic energy gap and consequently the density of excitations at ultra low temperatures drops exponentially. However, the symmetry of ^{3}He-B nearby any surface is broken as well and this leads to the creation of surface bound states. Their density depends on the quality of surface. If there is a mechanical resonator immersed in ^{3}He-B at ultra low temperatures (where there are almost no bulk excitations), the resonator interacts with excitations present in these surface bound states and its response at small displacements/velocities should be strongly affected. Moreover, the low energy excitations (with energies close to Fermi energy E_F) trapped in surface bound states can exhibit the properties of Majorana fermions. We are presenting our measurements of quartz tuning forks with different surface quality which demonstrate the important role of excitations trapped in the surface bound states.
Keywords: surface bound states, Majorana fermions, quartz tuning fork, superfluid 3He-B

Scattering through a straight quantum waveguide with combined boundary conditions

Jaroslav Dittrich, Philippe Briet, Eric Soccorsi

Straight planar waveguide with a simple combination of the Dirichlet and Neumann boundary conditions is considered. Scattering through the waveguide is studied by the stationary method which is justified and the existence of the stationary scattering wave function is proved.

Ideal hydrodynamic modeling of quark-gluon plasma

Zuzana Fecková, Boris Tomášik

We present a new algorithm for solving ideal relativistic hydrodynamics based on Godunov method with exact solution of Riemann problem with an arbitrary equation of state. Standard numerical tests are executed, such as sound wave propagation and schock tube problem. Low numerical viscosity and high precision are attained with proper discretization.

Open heavy flavor measurements at STAR

Pavol Federič

Measurements of open heavy flavor production at the Relativistic Heavy Ion Collider (RHIC) can play an important role in understanding properties of hot and dense nuclear matter created in ultrarelativistic heavy-ion collisions. Properties of this new state of matter, dubbed as the strongly interacting Quark-Gluon Plasma (sQGP), have been a subject of extensive measurements at RHIC in the past decade. Due to their large masses, charm and bottom quarks are produced in hard scatterings in the early stage of a collision and their number is virtually unaffected in later stages of the medium evolution. Heavy flavor quarks therefore provide a unique means of exploring the properties of the sQGP. In this talk we report on recent STAR open heavy flavor results at various center-of-mass energies in p+p, Au+Au and U+U collisions. The prospects of the heavy flavor program at STAR in light of recent detector upgrades will also be discussed.

Study of charge of top quark in experiment ATLAS

Pavol Federič

A precise measurement of the top quark charge is important as it is one of the basic top quark properties. It is generally accepted that the particle discovered at Fermilab in 1995 is the Standard Model (SM) top quark. However, a few years after the discovery a theoretical model appeared proposing an "exotic" quark of charge $-4/3$ and mass 170 GeV as an alternative to the SM top quark at this mass value. Though this model has already been partially excluded by Tevatron experiments, it was still important to carry out a more precise measurement to definitively resolve this question with more than 5   confidence level. A measurement of the top quark electric charge was carried out in the ATLAS experiment at the Large Hadron Collider using 2.05 fb−1 of data at a centre-of-mass energy of 7 TeV. In units of the elementary electric charge, the measured top quark charge is 0.64 ± 0.02 (stat.) ± 0.08 (syst.). This result strongly favours SM and excludes models with an exotic quark with charge $-4/3$ instead of the top quark by more than 8σ.

Ballistic persistent currents in disordered metallic rings: Origin of puzzling experimental values

Juraj Feilhauer, Martin Moško

A mesoscopic resistive metal ring pierced by constant magnetic flux supports a nondissipative persistent current. This current occures in a rings in normal (nonsuperconducting) state and is similar to the orbital electron current in a single atom. The existence of persistent current was confirmed experimentally in early 90's (Chandrasekhar et al. [*Phys. Rev. Lett.* **67**, 3578 (1991)]) but the measured values of persistent current were two orders of magnitude larger than predicted by theory derived by Cheung et al. [*Phys. Rev. Lett.* **62**, 587 (1989)]. Our aim is to explain origin of this puzzling experimental values. We calculate microscopically typical persistent current in a normal metal ring with disorder due to random grain boundaries and rough edges. If disorder is due to the grain boundaries, our results agree with theoretical result, derived by Cheung et al. and observed by Bluhm et al. [*Phys. Rev. Lett.* **102**, 136802 (2009)] and Bleszynsky-Jayich et al. [*Science* **326**, 272 (2009)]. If disorder is due to the rough edges, a ballistic current is found in accord with a puzzling experimental result, reported by Chandrasekhar et al. This ballistic current has a simple interpretation: It is due to a single coherent electron that moves in parallel with the edges and thus does not feel the roughness.

Addressing nanoscale soft-matter problems by computational physics and physical computation

Adam Gadomski, Roland Winkler

Soft-matter physics, being an emerging disciplne of physics, is almost naturally devoid of its own menhods, borrowing them mainly from condensed matter theory and statistical and computational physics. There exists a set of problems in this emerging area of (bio)physically motivated research that needs both computational physics' and physical-computation methods. Specifically, the problems of interest concern: (i) biomatter (dis)orderly aggregation; (ii) formation of viscoelastic assemblies; (iii) nanoscale-oriented and amphiphile-structure involving friction and lubrication effects on functioning of natural (articulating) systems. In the talk, a need of dedicated computational methods will be emphasized, and an expression of delineating the frontiers of them, will be specified in terms of practical usefulness and computational effectiveness. As a consequence, some response of formulating a special issue of a journal `http://www.frontiersin.org/Computational_Physicswillbesought`. An address of calling for own soft-matter physics' methods is then appropriate for its pre-invocation.

Recognizing an applied-physics and physicochemial succession of Jan Czochralski, a prominent European crystal grower

Adam Gadomski, Jan Klos

During the talk, a question will be posed, and then partly answered, as to what extent Jan Czochralski, a renown Polish chemist, crystallographer and metallurgist, or even material (viz metal) scientist, and aplied physicist [1–3], should in terms of his research achievements belong to (physicochemical) metallurgy [3] or ought to be recognized rather as a chemist, working with metals and their "derivatives"; not mentioning that some part of his research would gladly be placed within applied physics' context. The bare ground for answering the question consists of the fact that he did his research quite unseparably within physicochemical and/or mechanochemical (as a specific important subject) metallurgy of quite complex as well as very practical systems that he was able to resolve thoroughly by his investigations [1,2]. Moreover, his personal dillemas, and the overall historical and political context, impacted on his research accomplishments to a really great extent [1–3]. [1] A. Gadomski, "Jan Czochralski, the pioneer of crystal research", *Europhys. News* **42/5**, 22 (2011). [2] A. Gadomski, "Czochralski's contribution: 50 years on", *Europhys. News* **35/1**, 20 (2004). [3] A. Gadomski, "On some striking example of Jan Czochralski...", *Annals of Philosophy*, vol. **LXI**, no 4, pp. 137–148 (2013).

Ground state, magnetization process and magnetocaloric effect of the exactly solvable Ising-Heisenberg model with the diamond chain geometry

Lucia Gálisová

The results for the mixed spin-1/2 and spin-S Ising-Heisenberg diamond chains are presented. This class of models is exactly solvable by by combining Kambe projection method, decoration-iteration transformation and transfer-matrix method. Within the framework of these three exact analytical approaches, the ground-state configuration, the magnetization process and the magnetocaloric effect are discussed. It is shown that the increase of the Heisenberg spin value S raises the number of intermediate magnetization plateaux, which emerge in magnetization curves provided that the ground state is highly degenerate on behalf of sufficiently strong geometric frustration. On the other hand, all intermediate magnetization plateaus merge into a linear magnetization versus magnetic field dependence in the limit of classical Heisenberg spin $S \to \infty 1$. The enhanced magnetocaloric effect with cooling rate exceeding the one of paramagnetic salts is also detected when the disordered frustrated phase constitutes the ground state and the external magnetic field is small enough.

Barriers of using models and modeling in medical biophysics education

Viera Haverlíková, Ivan Haverlík

Using models and modelling in medical biophysics education play increasingly important role. The paper presents results of two pilot research studies realised in the frame of project KEGA 020UK-4/2014 "Innovation in the content, forms and methods of practical exercises of Biophysics and Medical Biophysics to the study of Medicine and Biomedical Physics". The research realised with first-year medical students was focused on students' conceptions about models and using electric circuit to model blood circulation. Results show that most students think of models as physical copies of reality, not as conceptual representations. This makes using of educational models ineffective, if there is none or low visual similarity with investigated phenomena. Understanding the theory of modelling was examined in survey realised with first-year-master-degree students of biomedical physics. One-third of respondents demonstrated serious misunderstanding of modelling principles and misunderstanding of relationship between original and model in science.

Development of children's modelling skills through non-formal activities

Viera Haverlíková

Modelling is recognised as one of basic scientific skills. Its development is declared as a part of education already at primary schools. Nevertheless pedagogical researches showed serious misunderstanding of modelling among pupils and students of all ages. New forms and methods enhancing modelling skills were developed during more than twenty years of non-formal educational project SCHOLA LUDUS. The paper presents summary of different forms of activities developed and proved within the frame of summer camps SCHOLA LUDUS: Experimentáreň that is designed to children aged 9 to 15.

Secondary pion beam for HADES experiment at GSI

Lukáš Chlad

During this summer, the HADES collaboration had the opportunity to measure pion collisions with different nuclei. These measurements were done with two objectives. The first being the investigations of hadrons with strange quarks and their behavior at normal nuclear density. The analysis of this will concentrate specifically on ϕ meson and Λ baryon production. The focus on properties of baryonic resonances in the region of N(1520) and N(1535) formed the second objective. Special emphasis is put on beamline detectors which use different particle detection techniques. In particular, the scintillator based Hodoscope and diamond based Start detector will be discussed. Advantages and disadvantages of using diamond detectors will be mentioned as well as their usage in future FAIR projects.

Thermally induced ionization and quenching processes in novel oxide and sulfide scintillation materials

Vítězslav Jarý, Eva Mihóková, Martin Nikl

An important factor that can significantly deteriorate scintillator performance or at least reduce the temperature range of its practical use is the thermally induced ionization of the excited state of luminescence centre [1–3]. As an example, typical activator in various hosts, Ce3+ ion, is shown in figure. Both its ground (4f) and excited (5d1) state are situated in the forbidden band of the host lattice, between the valence and the conduction band. The probability that the electron escapes from the 5d1 level to the conduction band of the host lattice after optical absorption is proportional to the Boltzmann factor $\sim \exp(-E_{\mathrm{ion}}/kBT)$, where E_{ion} is the activation energy of thermal ionization. In presented work, details concerning the delayed recombination theory, measurement and data evaluation will be given and its validity will be demonstrated using several different scintillation materials as an example. References: [1] Fasoli, M., A. Vedda, E. Mihóková, M. Nikl. *Physical review / B*. 2012, **85**(8), 085127. [2] Mihóková, E., V. Jarý, M. Fasoli, A. Lauria, F. Moretti, M. Nikl, A. Vedda. *Chemical physics letters*. 2013, **556**, 89–93. [3] Mihóková, E., V. Jarý, L. S. Schulman, M. Nikl. *Physica status solidi / Rapid research letters*. 2013, **7**(3), 228-231.

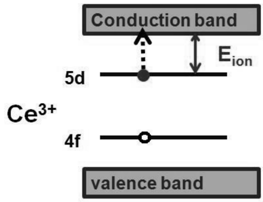


Figure 1: Scheme of the activator excited state ionization

Magnetocaloric effect of selected rare-earth materials

Jiří Kaštil

The value and the sign of the magnetocaloric effect depend on the type and strength of the interaction inside the material. It is of high interest to study magnetocaloric materials which are useful for refrigeration in wide temperature region as well as the materials which undergo several magnetic transition and show complex magnetic behavior. The present work is focused on two aspects. Development of measurement instrument for direct measurement of adiabatic temperature change, as this technique is not often used despite its importance, and presentation of results of magnetocaloric study of several materials. We have studied the intermetalic compound TbNiAl and effect of substitutions as well as anisotropy of magnetocaloric effect. This compound belongs to the RNiAl series which crystallize in the hexagonal ZrNiAl structure. TbNiAl shows complex magnetic behavior with frustrated terbium magnetic moments. The first antiferromagnetic ordering occurs at $T_N = 47$ K with all moment aligned along the c-axis (parallel or antiparallel). The second magnetic transition to another antiferromagnetic phase takes place at $T_1 = 23$ K. The perspective material of amorphous $Gd_{64}Co_{26}Al_9Y_1$ was prepared and measured. The magnetic measurement was performed on the SQUID magnetometer in temperature region from 300 to 4 K. Samples show the ferromagnetic behavior with magnetic ordering temperature $T_C = 108$ K that was determined from the temperature dependence of the magnetization. It was confirmed by the AC-susceptibility measurement and electrical conductivity measurement. Te magnetocaloric effect was observed in wide temperature region around magnetic phase transition which leads to a large RCP $= 540\,\mathrm{J{\cdot}kg^{-1}}$.

Time-resolved study of exciton and electron-hole liquid dynamics in diamond

Martin Kozák

This contribution is focused on the time-resolved study of recombination and diffusion of excited charge carriers in monocrystalline diamond. We investigated the picosecond dynamics of electron-hole liquid condensation using several techniques of time-resolved optical spectroscopy and demonstrate its evaporation by femtosecond laser pulses. We also proposed two new optical techniques for measurement of lifetime, diffusion coefficient and surface recombination velocity of excitons in diamond.

Nuclear effects in nucleon-nucleus collisions and nucleus-nucleus collisions

Michal Křelina, Jan Nemchik

We investigate nuclear effects in production of large-p_T hadrons and photons in nucleon-nucleus and nucleus-nucleus collisions corresponding to a broad energy range from the fix-target up to RHIC and LHC experiments. For this purpose we use the QCD improved quark-parton model including the intrinsic parton transverse momenta. This model is firstly tested reproducing well the data on p_T spectra of hadrons and photons produced in proton-proton collisions at different energies. For investigation of large-p_T hadrons and photons produced on nuclear targets we include additionally the nuclear broadening and the nuclear modification of parton distribution functions. We also demonstrate that at large-p_T and at forward rapidities the complementary effect of initial state interaction (ISI) causes a significant nuclear suppression. Numerical results for nucleus-to-nucleon ratios are compared with available data from the fix-target and collider experiments. We perform also predictions at forward rapidities which are expected to be measured in the future at LHC.

Study of high-p_T hadron-jet correlations in ALICE

Filip Křížek

Study of high-p_T hadron-jet correlations in ALICE Jets provide unique probes of the medium created in ultra-relativistic heavy-ion collisions. Here, the observed jet quenching phenomena in central collisions prove that jets are sensitive to interesting properties of strongly-coupled matter. In addition, jet production in elementary processes, such as pp collisions, is well understood within the framework of perturbative QCD, providing a rigorous theoretical basis for jet quenching calculations. In the talk we will report the measurement of semi-inclusive p_T spectra of charged particle jets that recoil from a high-p_T hadron trigger in Pb+Pb and pp collisions at $\sqrt{s_{NN}}$ = 2.76 TeV and $\sqrt{s}$ = 7 TeV, respectively. In this analysis, the copious yield of uncorrelated trigger hadron-jet matchings in central Pb+Pb collisions is removed by calculating the difference between two spectra corresponding to disjoint trigger hadron p_T ranges. This procedure does not impose any fragmentation bias on the recoil jet population, which is therefore collinear and infrared safe. The resulting distributions obtained for different values of jet resolution parameter are used to study the modification of jet structure in the medium. The results will be compared with calculations based on PYTHIA and JEWEL.

A Scanning Charge-Transient Microscope

Štefan Lányi, Vojtech Nádaždy

The response of semiconductors and dielectrics to voltage pulses resulting in capacitance and/or current transients is a proven method of analysis of defect states in the gap of materials. Whereas the capacitance response reflecting the relaxation of depletion layer in pn or Schottky junctions requires sufficiently high conductivity, the current or charge transients also from low-conductivity semiconductor structures or insulators can be analyzed. In focus of this contribution is the second method. Recently the sensitivity of a setup was increased to make the method applicable locally [1]. For good reproducibility of data the positioning of the probe, i. e. reproducible probe-to-surface distance or force pressing the tip to the surface, is now ensured using a tuning-fork-based lateral force AFM. We call the instrument Scanning Charge-Transient Microscope (SQTM). We present some results obtained on thin pentacene film and monomolecular graphene oxide. References: [1] Š. Lányi, V. Nádaždy, *Ultramicroscopy* **110** (2010) 655-658.

Melting Behavior of Two-Dimensional Air-Driven System of Small Magnets

Martin Liščinský, Michal Géci, Mária Šviková

he study of self-organization of particles is important for both fundamental research and applications. For example in the fabrication of nano-structured particle systems and in soft-matter physics which include colloids, liquid crystals, foams, granular materials and even biological tissues. In this work, we study configurational and melting properties of the system of finite number of small disc magnets moving on an air layer produced by an air table to imitate two-dimensional (2D) Wigner-like crystal. By changing the velocity of the air current blown to the air table we influence effective temperature calculated through particle velocities. Our results show, that a 2D hexagonal lattice forms at low temperature while with increasing temperature we can observe a change of the lattice symmetry from hexagonal to square. The dependence of averaged number density of defects on the temperature exhibits sudden increase indicating transition to the liquid phase. Particle trajectories in this phase reveal the surprising square shell structure. Experimental results are compared with a molecular dynamics simulation based on Verlett algorithm.

Cascade projects competition for high school students

Ivan Melo

Cascade projects is a competition for high school teams of 3–6 students. The teams with help from physicists work on projects from particle physics for several weeks and prepare 20 min presentations which they deliver in their schools. They send videos of their talks to the jury which selects the best teams. The competition is quite popular.

Transverse momentum spectra fits in Pb Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV

Ivan Melo, Boris Tomášik

We analyse identified hadron spectra in transverse momentum with the help of blast-wave model. Our approach properly includes all resonance decays contributing to hadron production. It is shown that there is no window in the transverse momentum where this contribution can be safely neglected in order to use simpler analytical formulas in the fit procedure. Based on the comparison of theoretical results to data we identify the fiducial range for the fit. The fit is also performed on Lambda's, Xi's and Omega's and the possibility of a different freeze-out time for these species is discussed. The freeze-out temperatures and transverse velocities for different centralities are compared with previously published ALICE results.

Anisotropic flow and the reaction plane reconstruction with the CBM experiment

Vasily Mikhaylov, Pavel Tlusty, Andrej Kugler, Selim Seddiki, Ilya Selyuzhenkov

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) will study heavy-ion collisions at beam energies 2 AGeV–35 AGeV. The Projectile Spectator Detector (PSD) of the CBM is a compensating hadron calorimeter, which will measure projectile spectator nucleons and fragments with the aim to determine reaction centrality and reaction plane. Preliminary results of particles flow simulation and the reaction plane reconstruction performance with the PSD detector are presented. Directed flow is simulated for Au+Au collisions using four heavy-ion collision event generators: UrQMD, DCM-QGSM, LA-QGSM and HSD. Simulations are performed for the range of beam energies between 2 and 30 AGeV, which covers the expected beam energies of SIS100 and SIS300 accelerator rings at FAIR. Results are compared with the experimental data from AGS E895 and STAR.

Experimental Realization of Quantum Information Processing

Martina Miková, Helena Fikerová, Ivo Straka, Michal Mičuda, Michal Sedlák, Miroslav Ježek, Miloslav Dušek, Radim Filip, Jaromír Fiurášek

The talk will be focused on two recent results awarded by Milan Odehnal Prize 2014. The first part of the talk will discuss an experimental realization of a programmable quantum phase gate using an electronic feed-forward loop to increase the success probability of the gate. The second part will be focused on a novel parameter quantifying the particles' indistinguishability in degrees of freedom not used for encoding information. An additional experiment will be introduced to demonstrate the significance of this parameter.

Investigation of the Higgs boson properties

Michaela Mlynáriková

The Standard Model of elementary particles (SM) predicts the existence of a neutral scalar Higgs boson. However, there are also extensions of the SM (such as the MSSM) in which a number of Higgs bosons is predicted. Especially the additional presence of pseudoscalar and charged Higgs bosons represents one of the crucial differences between the SM and its extensions. We develop a method for determination of the spin and parity of the Higgs boson in several $H \to \tau\tau$ decays. Both the hadronic and leptonic decay of the tau leptons is studied.

The method is based on the angular and energy correlations of charged final products from the decays mentioned above. Additionally, we study the possibility of signal (Higgs boson decay) and background ($Z \to \tau\tau$ decay) discrimination, when one considers a decaying boson with spin 1. All calculations are done in the leading order of perturbation theory.

On a possibility to combine plasma tomography with unfolding of energy spectra in fusion research

Jan Mlynář, Viktor Loffelmann

Plasma tomography can determine spatial distribution of radiation sources from the measured radiation projections, however, the tomographic inversion presents an ill-conditioned problem and the experimental data are usually sparse. Dedicated regularisation algorithms have proved to provide robust and reliable solution of the tomographic inversion in spite of these challenges. The expertise includes studies of emissivity distribution of fusion neutrons at the Joint European Torus JET. Besides, it was demonstrated that the same regularisation techniques can be applied to other inverse problems, e.g. to the spectrum unfolding based on knowledge of the detector response function. In particular, energies of fusion neutrons were successfully unfolded from data of a dedicated scintillation spectrometer at JET. In ITER, a set of scintillation spectrometers is foreseen to be installed in order to provide data on both energy and spatial distribution of fusion neutrons. In this contribution, a possibility of a combined inversion task is considered, solving the required tomography inversion and spectrum unfolding as a single inverse problem. This method is proposed in contrast to a more conservative approach, where the tomography inversion is run on unfolded spectra or vice versa.

Spin squeezing

Tomáš Opatrný

Suppressed noise in two-mode multi-particle systems known as “spin squeezing” is an essential tool in quantum metrology protocols. The interferometric schemes utilizing this effect cover broad area of possible physical systems, ranging from collective spins of neutral atoms interacting by collisions, atoms interacting with light by Faraday rotation and ac-Stark shift, atoms interacting by Rydberg blockade, polarized light, to Bose-Einstein condensates (BEC) in double-well potentials (bosonic Josephson junctions). Typically, the preparation of spin squeezed states is based on nonlinear inter-particle interactions. I will discuss a unified tensor description of quadratic spin squeezing interactions, covering the single- and two-axis twisting as two special cases of a general scheme. Equations of motion of the first moments and variances are derived and their solutions are discussed from the prospect of fastest squeezing generation. It turns out that the optimum rate of squeezing generation is governed by the difference between the largest and the smallest eigenvalues of the twisting tensor. A cascaded optical interferometer with Kerr nonlinear media is proposed as one of possible realizations of the general scheme. [`http://arxiv.org/abs/1408.3265`]

Status of the COMPASS tokamak and recent results

Radomír Pánek and the COMPASS team

The COMPASS tokamak is a compact experimental device for thermonuclear fusion research operated in a divertor plasma configuration with ITER-like plasma cross-section.

COMPASS operates with maximum plasma current up to 400 kA and toroidal magnetic field up to 2.1 T and with additional plasma heating by Neutral Beam Injection system (NBI). Recently, an H-mode has been achieved in COMPASS. The H-mode is generated by an increase of the plasma current above 240 kA or a pulse of NBI system. The L-H transition is characterized by a sudden decrease of Dalpha signal as well as its fluctuations. The H-mode is accompanied by characteristic plasma instabilities (Edge Localized Modes – ELMs) of different types with frequencies in the range of 80 Hz–2000 Hz or exhibits so called ELM-free periods. This contribution will present a characterization of edge plasma during H-mode as a basic operational scenario in COMPASS with a focus on the ELM classification. In addition, the characterization of ELM parameters using different probe techniques will be provided. Examples of edge electron temperature and density profiles measured by High Resolution Thomson scattering diagnostics will be also presented. Moreover, a new system for generation of magnetic perturbation (MP) has been put into operation recently. The saddle coils on the vacuum vessel are used to introduce $n = 2$ magnetic perturbation. The first measurement of MP effect on plasma in L- and H-modes will be presented, including the strike-point splitting, response of plasma to perturbation, etc.

BIOMAT: Experimental Facility for Biophysics and Material Science at FAIR

Radek Pleskač

The APPA (Atomic physics, Plasma Physics and Applications) is one of four pillar projects at future FAIR (Facility for Antiproton and Ion Research in Europe) in Darmstadt. The BIOMAT facility is planned in APPA cave in order to perform experiments in biophysics and material science. After a short overview of the whole APPA project some examples from the biophysics scientific program will be presented. At the end a possible collaboration with scientists from the Czech Republic, Slovakia, Hungary and Austria will be discussed.

Structural and optical properties of Manganese ferrite thin films fabricated using modified sol-gel method

Ramakanth Illa, Jaroslav Hamrle, Lenka Matejová, Kateřina Mamulová Kutláková, Vladimír Tomášek, Jaromír Pištora

New magnetic materials have attracted much attention due to the integral role they play in magnetic sensing and high-density data storage [1]. Among various magnetic materials, ferrites have interesting magneto-optical applications due to their unique physical properties [2]. Nanostructured thin films of Manganese ferrite were fabricated using a modified sol-gel method. The structural and optical properties of the fabricated thin films have been investigated. The films were thermally annealed at 300 °C, 400 °C, 500 °C and 600 °C respectively. The microstructures of the ferrite thin films have been investigated using X-ray diffraction (XRD) technique and the optical properties using spectroscopic ellipsometry. The structural analysis carried out using XRD for Manganese ferrite thin films annealed from 300 °C–600 °C indicated that they have single crystalline phase with spinel structure without any preferred crystallite orientation when the annealing temperature was 400 °C. While at 500 °C, the intensity of characteristic peaks increased significantly, and the crystalline phase of ferrite tended to be more complete. This structural transition between 400 °C and 500 °C has also been reflected by change of optical properties. Acknowledgements: The authors acknowledge partial support from the project CZ.1.05/1.1.00/02.0070 (IT4Innovations), PostDoc II project Opportunity for young researchers Reg. No. CZ.1.07/2.3.00/30.0055 and GACR 13-30397S. References: [1] K. Brachwitz, T. Bontgen, M. Lorenz and M. Grundmann, *Appl. Phys. Lett.*, 2013, **102**, 172104. [2] J. H. Yin, B. H. Liu, J. Ding and Y. C. Wang, *Bull. Mater. Sci.*, 2006, **29**, 573.

Properties of UFeSb2 uranium antimonide

Marian Reiffers, A. P. Gonçalves, M. S. Henriques, J. C. Waerenborgh, I. Curlik, S. Ilkovič

UFe1-xSb2 is a ternary uranium phase that crystallizes in the tetragonal HfCuSi2-type structure (SG. P4/nmm), the U and Fe atoms being located in one position (2c and 2b, respectively), while Sb occupies two sites (2a and 2c). This phase is closely related to the USb2 binary compound (Cu2Sb-type structure, SG. P4/nmm), which is a layered structure with Sb(I), U and Sb(II) sheets stacked along the c axis: UFe1-xSb2 can be seen as formed from USb2 by inserting an additional Fe layer between the planes that compose the Sb(II) sheets. UFeSb2 is the limit compound in of this homogeneity range, being reported the identification of its crystal structure (HfCuSi2-type), unit cell parameters and electrical resistivity as a function of temperature. The binary antimonide USb2 orders antiferromagnetically below TN = 206 K, the refinement of its magnetic structure from neutron diffraction data showing a sequence of alternating (↑↓↓↑) U ferromagnetic layers and a magnetic moment of ~ 1.9B/U. In UFeSb2 the lowest U-U distance (4.327 Å, corresponding to the a cell parameter) is well above the Hill limit, pointing to a strong chance of magnetic ordering for the U sublattice, similarly to the USb2 case. However, it is not excluded the possibility of a Fe magnetic contribution, which leads to the existence of two potential magnetic sublattices in UFeSb2. Indeed, the reported resistivity data shows a maximum at $\sim$40 K that can be related to a magnetic transition. Here we present the synthesis and a detailed study on the UFeSb2 compound, by powder X-ray diffraction, electrical resistivity, magnetoresistance, magnetization, specific heat and Mössbauer spectroscopy measurements. A UFeSb2 polycrystalline sample was prepared by arc-melting, followed by annealing at 750 °C for one week. The Rietveld refinement confirms that UFeSb2 crystallizes in the HfCuSi2-type structure and indicates that the majority of the sample consists of UFeSb2 (98.2 w%) and that only minor amounts of FeSb1+x and α-Fe (1.7 and 0.1 w%, respectively) exist. All the nearest neighbor atoms of U are at distances close to or higher than the metallic radii sum, pointing to the possibility of a non negligible U magnetic moment. However, the very short Fe-Sb1 distances indicate strong interactions between these atoms and a probable collapse of the Fe magnetic moments. The low temperature electrical resistivity versus temperature results is similar to those previous reported, showing a maximum at $\sim$40 K under zero applied magnetic field. At higher fields the maximum broadens and shifts to higher temperatures, as expected for a ferromagnetic-type transition. The temperature dependence of the UFeSb2 specific heat shows only a very small anomaly at TC, pointing to itinerant magnetism. At low temperatures the specific heat follows $C_P = \gamma T + \beta T^3$, with $\gamma = 51(1)$ mJ/mol·K^2 and $\beta = 0.55(1)$ mJ/mol·K^4 ($\theta_{\mathrm{D}} = 152$ K). The γ value points to a relatively high density of electronic states at the Fermi level and classifies this compound as an enhanced correlated system.

Preliminary results of pion induced reaction with carbon and polyethylene targets obtained by HADES-GSI in 2014

Pablo Rodríguez Ramos

In the summer of 2014 HADES were measuring with secondary pion-beam using different targets. The programme of this time was to measure dielepton radiation from baryonic resonances. In particular we investigated sub-threshold coupling of ρ to baryonic resonances in the second resonance region N(1520), N(1535). Most of the beam time was dedicated to measurement of e^+e^- production from PolyEthylene target at pion beam momentum of 0.69 GeV/c. The contribution from pion-proton can be separated from contribution of pion-carbon interaction by means of kinematical constraints. Therefore it was possible to measure at the same time $\pi - p \to e^+e^-n$ and inclusive e^+e^- production on carbon. In addition we run part of the time with pure carbon target to allow precise background subtraction for pion channels.

Charged jet reconstruction in AuAu collisions at $\sqrt{s_{NN}}$ = 200 GeV at RHIC

Jan Rusňák

Jets represent an important tool to explore the properties of the hot and dense nuclear matter created in heavy-ion collisions. However, full jet reconstruction in such events is a challenging task due to extremely large and fluctuating background, which generates a large population of combinatorial jets that overwhelm the true hard jet population. In order to carry out accurate, data-driven jet measurements over a broad kinematic range in such conditions of small signal to background, we use several novel approaches in order to measure inclusive charged jet distributions and semi-inclusive charged jet distributions recoiling from a high pT hadron trigger in central Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. In addition we present the measurement of the di-jet transverse momentum asymmetry, AJ. A very low infrared cut-off on jet constituents of 200 MeV is applied in all measurements. These jet measurements allow a direct comparison of jet quenching at RHIC and the LHC.

Tomographic methods in modern optics

Bohumil Stoklasa et al.

The talk will shortly present some applications of quantum tomography in modern optics, work awarded by Milan Odehnal Price 2014. Quantum tomography will be present as a useful measurement technique for both classical and quantum problems. Experimental results of wavefront tomography and polarization squeezed light tomography will be shown together with numerical analysis of quantum tomography protocols for incomplete measurements and measurement apparatus calibration.

Electromagnetic calorimeter for the HADES spectrometer

Ondřej Svoboda et al.

The HADES spectrometer currently operating on the beam of SIS18 accelerator in GSI will be moved to a new position in the CBM/HADES cave of the future FAIR complex. Electromagnetic calorimeter (ECAL) will enable the HADES@FAIR experiment to measure data on neutral meson production in heavy ion collisions at the energy range of 2–10 A GeV on the beam of the new accelerator SIS100@FAIR. Calorimeter will be based on 978 massive lead glass modules read out by photomultipliers and a novel front-end electronics. Layout of the ECAL detector as well as first beam tests of single modules and electronics will be presented.

Strangeness enhancements in heavy-ion collisions from SPS to LHC

Ladislav Šándor

Studying strange and particularly multi-strange particle production in relativistic heavy-ion interactions is a unique tool to investigate the properties of the hot and dense matter created in the collision, because of no net strangeness content in the initially colliding nuclei. In particular, an enhanced production of strange particles in A-A with respect to p-p interactions was one of the earliest proposed signature of the creation of a deconfined Quark-Gluon Plasma (QGP). The results of strangeness enhancement measurements from the WA97/NA57 (SPS), STAR (RHIC) and ALICE (LHC) experiments are briefly reviewed. The energy, centrality and strangeness content dependencies of enhancements are discussed.

The NPI Center of Accelerators and Nuclear Analytical Methods (CANAM), Basic and Applied Research with Ion Beams

Eva Šimečková, P. Bém, M. Majerle, J. Mrázek, J. Novák, M. Štefánik

The Nuclear Reaction Department of NPI – the member of the European Consortium on Nuclear Data – provides experimental data required for the validation of computational tools and the nuclear data libraries that are being developed for fusion applications. A determination and validation of fusion related activation cross-sections of neutron and deuteron induced reactions are performed using CANAM infrastructure – fast neutron sources and ion-beam irradiation chamber. A methodical approach and some results will be presented.

Simulations for the HFT-Pixel detector at the STAR experiment

Miroslav Šimko

The Heavy Flavor Tracker (HFT) is a new state-of-the-art detector installed at the STAR experiment in January 2014. It consists of four layers of silicon detectors divided into three subsystems: A double sided strip detector SSD (Silicon Strip Detector), a silicon pad detector, called IST (Intermediate Silicon Tracker), and finally two layers of pixel detectors, based on the state-of-the-art MAPS technology. The HFT provides excellent primary and secondary vertex position measurement capability (pointing resolution of $\sim 30\,\mu$m) which allows for measurements of hadrons containing heavy flavor, such as D^0 and Λ_c. Moreover, the combined analysis of the identified charm hadrons and the non-photonic electrons will allow the measurement of bottom production and azimuthal anisotropy at RHIC top energy. A new tool DIGMAPS [4] has been developed for the simulation of the response of the pixel sensors. Results from tuning of DIGMAPS as well as comparison between simulation and recently taken data by the STAR experiment will be presented. References [1] STAR Heavy Flavor Tracker Technical Design Report, `https://drupal.star.bnl.gov/STAR/starnotes/public/sn0600`. [2] J. Kapitan, *Eur. Phys. J. C* **62**, 217 (2009). [3] J. Bouchet, *Nucl. Phys. A* **830**, 636c (2009). [4] A. Besson, DIGMAPS Documentation, A standalone software tool to study digitization with MAPS sensors (2011), `http://www.iphc.cnrs.fr/IMG/pdf/DIGMAPS_doc.pdf`.

Center of Accelerators and Nuclear Analytical Methods (CANAM): Fast Neutron Generators

Milan Štefánik, P. Bém, M. Honusek, M. Majerle, J. Mrázek, J. Novák, E. Šimečková

The cyclotron based neutron generators of the white- and quasi-monoenergetic spectra are operated under the CANAM infrastructure of the NPI ASCR Řež utilizing the variable-energy proton beam (up to 37 MeV) and the D2O (flow), Be (thick), and Li(C) targets. The intensity and the energy range of the produced neutron fields are suitable for the validation of the neutron cross-sections for fusion applications. The accelerator driven fast neutron sources are characterized, and the neutron fields with a broad spectrum determined by the multi-foil activation technique and validated against the Monte Carlo MCNPX calculations are presented. The research programs realized in this neutron fields are outlined.

Study of jet quenching in heavy ion collisions at LHC using ATLAS detector

Pavol Štefko

Quark-Gluon Plasma (QGP) is one of the most extreme and rare states of matter which exists only in extraordinary conditions of heavy-ion collisions in particle accelerators. Interactions between the partons and the hot, dense QGP are expected to cause the loss of the jet energy, phenomenon called jet quenching. In this talk we provide an introduction to the problematics of ultra-relativistic heavy ion collisions and we show how the jet quenching can be used to analyze the properties of QGP. We also present preliminary results of the jet analysis done on the data taken by the ATLAS detector during the 2011 heavy-ion run at the LHC. Jets are studied as a function of collision centrality and dijet energy imbalance. Dijets are observed to be increasingly asymmetric with increasing centrality. The study of charged particles indicates an increase of yields of low-pt tracks in events with strongly quenched jets.

J/psi measurements in STAR

Barbara Trzeciakand STAR Collaboration

The suppression of charmonium production in high energy heavy-ion collisions relative to proton-proton collisions due to the color screening was proposed as a signature of the Quark-Gluon Plasma formation. Studies of J/psi production and elliptic flow v2 in nuclear collisions can provide insight into the thermodynamic properties of the hot and dense medium created in relativistic heavy-ion collisions at RHIC. However, there are other effects that may affect the observed charmonium production and complicate this simple picture, such as cold nuclear matter effects or regeneration. Measurements of the J/psi production in different colliding systems, centralities and collision energies may help to systematically understand the J/psi production mechanisms and interactions with nuclear matter. In this talk, we will present measurements of the J/psi production in STAR at mid-rapidity via the di-electron decay channel in various colliding systems and energies. We will also report the first psi(2S) measurement at $\sqrt{s} = 500\,\mathrm{GeV}$. Moreover, prospects of charmonium measurements with the newly upgraded STAR detector will be reported.

Development of high-repetition rate lasers in HiLASE project

Hana Turčičová et al.

The HiLASE project, co-funded by the European Regional Development Fund, aims the development of a new generation of diode pumped high-average-power lasers which will be used in industry and science for special applications. The main part of our in-house development is based on a new progressive technology where the lasing medium has a shape of a thin disk. The thin disk in our case is a single crystal of Yb:YAG (1 cm diameter, 0.2 mm thickness) inserted as an active mirror into a resonator of a regenerative amplifier. Opposite to the thin disk is a parabolic mirror assuring many passes of the pump light from laser diodes through the thin lasing medium so that practically all the pumping radiation is absorbed. The amplification of oscillator pulses proceeds in those thin disk regenerative amplifiers in dependence on the beam parameters required for our beamlines called A, B and C. Beamline C is designed to generate 1 picosecond long laser pulses with an average power of 500 W and repetition rate of 100 kHz. The state-of-the-art of the HiLASE project will be presented together with the intended applications.

Study of jet properties in pp collisions at 7 TeV and pPb collisions at 5.02 TeV using POWHEG-Box

Michal Vajzer

In this contribution, next-to-leading order simulations of jet production are presented. These simulations are carried out using POWHEG-Box framework, implementation of POWHEG NLO generator, with parton showering provided by Pythia8. We focus on proton-proton collisions at centre of mass energy of 7 TeV and proton-lead collisions at 5.02 TeV, where we study jet production cross sections and ratio of jet spectra reconstructed using different resolution parameter, as this measurement is much more sensitive to expected to cold nuclear effects. Parton distributions considering effects of heavy ions are implemented using nuclear parton distribution functions such as HKN07 and utilising nuclear modification factors provided in EPS09. Jet reconstruction is done using standard anti-k_T algorithm, included in FastJet package.

Quartz tuning fork as a high Q-value resonator – its vacuum properties in high magnetic field up to 8 tesla and at mK temperatures

František Vavrek, Marcel Člověčko, Martin Kupka, Peter Skyba,

Quartz tuning forks are very popular experimental tools widely applied in low temperature physics as mechanical resonators and cantilevers in the study of quantum liquids, STM and AFM techniques, etc. As an added benefit, these forks being cooled, have very high Q-value, typically 10^6 and their properties seems to be magnetic field independent. We present our preliminary vacuum measurements of a commercial tuning fork oscillating at frequency 32 kHz conducted in magnetic fields up to 8 T and at temperature $\sim$10 mK. We found an additional weak damping of the tuning fork motion depending on magnetic field magnitude and we discuss physical nature of the observed phenomena.

Studies of nanoparticle Langmuir films by GISAXS method

Karol Vegso et al.

GISAXS is a versatile tool used for structural characterization of nano-patterned thin films, nanoparticle assemblies, polymer blends, or corrugated surfaces. We present potential of this method on two studies. The first one concerns an in-situ characterization of a nanoparticle Langmuir film at the air-water interface. Here, the main advantage of GISAXS comparing to the scanning probe methods (AFM, SEM) is that it allows to examine the structure evolution of the nanoparticle Langmuir film under continuous compression. On increasing the pressure, a slight decrease in the interparticle distance by $\geqslant 1$ Å was observed prior to the collapse of the nanoparticle monolayer that was attributed to the deformation of the organic shell molecules covering the nanoparticles. This highly non-equilibrium phase with important implications for preparation of homogeneous nanoparticle monolayers at the air-water interface has not been observed yet. It could be detected only by fast GISAXS measurement probing the immediate response of the system. The second example concerns the effect of the preparation method on the structure of 3D nanoparticle assemblies. An analysis of a GISAXS pattern of a nanoparticle assembly consisting of six layers prepared by the repeated (layer-by-layer) Langmuir-Schaefer deposition revealed vertically uncorrelated structure (nanoparticle multilayer) while the solvent-evaporation assisted self-assembly resulted in formation of a vertically correlated structure (3D nanoparticle crystal). These conclusions could be made relying on characteristic diffraction spots in the GISAXS patterns that were analyzed by original structural models based on paracrystal concept. The structure differences in terms of the mean interparticle distance, interlayer distance, layer sequence, texture, etc. have direct impact on the resulting physical properties.

Metallic glasses crystallization by nuclear forward scattering of synchrotron radiation

Vlastimil Vrba, Vít Procházka, Marcel Miglierini

During last decades, metallic glasses have been under interest for their unique mechanical, magnetic and other properties. Recently, metallic glasses (with their amorphous structure) also serve as starting material for developing magnetic nanocrystalline alloys. Detailed study of the crystallization process is important for understanding the relation between the microstructure and the magnetic properties of these materials. Crystallization process was usually studied by ex-situ experiments of transmission Mössbauer spectroscopy, magnetometry, and in-situ differential scanning calorimetry. Nuclear forward scattering (NFS) is an experimental method based on Mössbauer effect which, due to huge brilliance of the third generation of synchrotrons, allows in-situ investigations of the crystallization dynamics. NFS is an irreplaceable tool for an on-fly inspection of the whole crystallization process. It offers information both on the structural and magnetic order which is complemented by the data on the valence state via hyperfine parameters (i.e., quadrupole splitting, magnetic hyperfine field, and isomer shift). NFS experiments were performed at the ID18 beamline in ESRF (Grenoble). 20 mm thick ribbons of $Fe_{79}Mo_8Cu_1B_{12}$ enriched by ^{57}Fe to aproximately 50 % were thermally treated under isothermal conditions and constant temperature increase at zero and nonzero external magnetic field. Formation of crystalline nanograins was observed. Formation of nanograins in an applied external magnetic field starts at lower temperature.

Posters

The internal structure of floating DPPC bilayers investigated by specular neutron reflectometry

Michal Belička, T. Kondela, G. Fragneto, N. Kučerka

Specular neutron reflectometry (SNR) is a widely used technique for the thin layer structure investigation. Its application to lipid bilayer systems was restricted mainly to bilayers attached to silicon blocks, which are not biologically relevant because of interactions between the block surface and the adjacent bilayer leaflet. The described complication can be completely circumvented by a still novel method of preparation of floating lipid bilayers, which are located above supported ones and kept on their location only by interbilayer interactions. In combination with a high flux of the ILL neutron source this allowed us to use SNR for structural studies of lipid bilayers on the level of molecular components. Lipid molecules are represented by choline, phosphate, carbonyl glycerol, methylene and methyl groups. Initially, this bilayer model was successfully applied to obtain the internal structure of a dibehenoylphosphocholine (DBPC) bilayer individually deposited on a silicon block in a gel phase. In the second step this result was used as an input for the evaluation of reflectivity curves measured on a system of a deuterated dipalmitoylphosphocholine (DPPC) bilayer floating over the supported DBPC bilayer. The internal structure of floating DPPC bilayer was successfully evaluated only in its fluid phase. The corresponding structural parameters showed a good agreement with the results provided by small angle neutron scattering on unilamellar vesicles formed by the same lipid. Acknowledgement. This work was supported by the VEGA 1/0159/11 grant. The authors would like to acknowledge ILL for beamtime and Giovanna Fragneto for support provided during the measurements. We acknowledge the use of the preparation and characterization tools provided by the Partnership for Soft Matter (PSCM) at ILL.

Raman study of potassium doped Multi Walled Carbon Nanotubes

Sami Dzsaber, Julio C. Chacón Torres

Doping carbon nanostructures with alkali atoms allows to adjust the electron number in a controlled manner, making it possible to map their band structure, and to shift the Fermi level deep into the conduction band. In Potassium doped Multi Wall Carbon Nanotubes (MWCNTs), strong charge transfer can be achieved via inter-planar doping, where the Potassium atoms are located between the walls of the MWCNT. Herein, we present a Raman spectroscopy study of Potassium doped MWCNTs, from which changes in the crystal- and electronic structure are observed. Our results suggest that the crystal structure of the doped MWCNTs are very similar to Stage-1 potassium doped graphite (KC8).

Piezoelectric ceramics transformers

Jiri Erhart

Piezoelectric transformer is a simple resonant device working in actuating and sensing mode at the same time. Transformer electrode is divided into primary (actuation) and secondary part (sensing). First applicable piezoelectric transformer on piezoelectric ceramics was patented by Ch. A. Rosen et al. in 1958 [1] and it is called "Rosen-type" transformer. It is one of the most successful transformer designs up to now. Since that time, various transformer geometries were studied theoretically as well as experimentally. Applications of piezoelectric transformers include mainly driving electronics for cold cathode fluorescent lamps and cold plasma generation. Presented contribution gives overview of state-of-art of piezoelectric transformer technology, i.e. vibration mode types, electrode design, transmitted power, efficiency etc. Our own contribution to the field includes various planar vibration mode transformers studied at the Technical University of Liberec. Main transformation parameters (i.e. transformation ratio and efficiency) are measured as a function of frequency and resistive load at output circuit for many transformer geometries with homogeneously as well as non-homogeneously poled piezoelectric ceramics PZT. Examples of transformer analytical modeling, digital holographic interferometry and infrared imaging are additionally presented. [1] Ch. A. Rosen, K. A. Fish and H. C. Rothenberg: Electromechanical transducer, U.S. patent No. 2,830,274 (1958).

Dihadron angular correlations in Pb+Pb collisions with HYDJET++ model

Gyulnara Eyyubova

The hybrid model HYDJET++, which includes soft and hard physics, is employed for the analysis of azimuthal anisotropy harmonics and dihadron angular correlations measured in Pb+Pb collisions at $\sqrt{s} = 2.76$ TeV. The soft part of the model represents a thermal hadron production at the freeze-out hypersurface in accordance with hydrodynamical calculations. The possible triangular shape fluctuation of the initial overlap density of the colliding nuclei was implemented in HYDJET++ by the modulation of the final freeze-out hypersurface with the appropriate triangular coefficient, which results in triangular flow v3. Along with elliptic flow v2, it generates higher order flow coefficients, as well as a specific structure of dihadron angular correlations on relative azimuthal angle in a broad range of relative pseudoraidities ($\Delta\varphi\Delta\eta$). The comparison of model results with the LHC data on short- and long-range angular correlations is presented for different collisions centralities and transverse momenta intervals.

Unfolding of energies of fusion products measured by the activation probe at JET

Ondřej Ficker, Jan Mlynář, Georges Bonheure, Karel Bauer, Andrea Murari, Sergey Popovichev

The diagnostics of charged fusion products in the tokamak is very challenging. The requests for such diagnostics vary from the absolute calibration and the satisfactory accuracy to the ability to withstand the harsh environment in the large tokamak reactor. A novel type of detector that meets most of these requirements – an activation probe – was tested in JET and other European devices. This detector is extremely robust due to its simple and durable construction. It consists of simple holder with several samples of well defined isotopic abundance. The materials of the samples are selected with respect to the undergoing reactions during the exposition to the flux of fusion products. The content of the products of such reactions in these materials could be measured via ultra-low-level gamma spectroscopy in specialized laboratories. The feasibility of the proton spectrum reconstruction from measured activities is examined in this contribution with the help of the algorithm based on the

Tikhonov regularisation constrained by minimum Fisher information. The reliability of the method was previously illustrated using synthetic proton and real neutron data measured by the JET activation probe. The reconstruction of the proton spectrum is less reliable as it depends on several geometrical factors, therefore a basic analysis of stability is introduced to support the encouraging results.

Upsilon production at the STAR experiment

Jana Fodorová

Quark-gluon plasma (QGP), a novel state of deconfined nuclear matter governed by partonic degrees of freedom, can be created in high-energy collisions of heavy nuclei. Properties of this new phase of strongly interacting matter have been extensively studied by the STAR experiment at the Relativistic Heavy Ion Collider (RHIC) in Brookhaven National Laboratory. Production of quarkonia, i.e. bound states of heavy quark (c and b) and antiquark pairs, is an important tool for the QGP studies. Quarkonia have been predicted to dissociate inside the QGP due to the screening of the quark-antiquark potential by thermalized partons. Different quarkonium states are expected to dissociate depending on their binding energies and the temperature of the medium. Hence, the observed suppression pattern of quarkonium states allows us to determine the temperature of the QGP. However, there are other effects, such as cold nuclear matter effects and regeneration, which can also influence quarkonium production. Bottomonia are expected to be less affected by these effects than charmonia and, therefore, are considered to be a cleaner probe of the QGP. In this poster, recent STAR results of Υ production in d+Au and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV will be presented and compared to selected results from the LHC experiments.

Simulation of non-localized to localized transition using quantum walks

Aurél Gábris, Hynek Lavička, János Asbóth, Igor Jex

Quantum walks are one of the candidates as a basis for efficient quantum simulators. Key features of quantum walks are iterative unitary evolution consisting of non-trivial site-local, and uniform nearest-neighbour operations. One dimensional quantum walks have been shown theoretically and experimentally to exhibit Anderson localization under phase noise. A mathematical result in the form of an existence theorem indicates that a transition from non-localized to localized may occur also in a disordered quantum walk on a two dimensional square lattice. In our poster we present the results of numerical calculations aimed at locating this transition in the phase space of the coin operator and the degree of disorder. The calculations mainly employed the finite size scaling analysis of the walker's variance, and supplemented by a similar analysis of the spectral features of the evolution operator. The research has been partially supported by the National Excellence Program of Hungary under grant No. TÁMOP 4.2.4.A/2-11-1-2012-0001, and the Grant Agency of the Czech Republic under No. 13-33906S.

Thermodynamic Properties of Two-Dimensional System of Small Magnets

Michal Géci, Martin Liščinský, Mária Šviková

In granular system (collection of macroscopic particles) the dissipative nature of grains means that any dynamical study requires energy injection, typically involving vibration or shear. An important feature of this class of systems is that the driving and dissipation mechanisms can be made to balance such that a steady state is achieved. Recent investigation of such non-equilibrium steady states has shown that connections with equilibrium statistical mechanics may provide a useful analogy. In our experiment we study system of 6 mm sized disc magnets moving on an air layer. Uniform steady – state motion is excited by air, blown into air table. Magnetic moments of the magnets in our experiment are oriented perpendicularly to the layer so that magnets repel each other by dipolar magnetic interaction. By changing the velocity of the air current blown to the air table we influenced effective temperature calculated through particle velocities. The movement of particles was recorded with a webcam and we created scripts in Matlab to analyze videos and to determine particle trajectories, velocity distribution, pressure, Voronoi diagrams of next neighbors and distributions of shape factor and angles in Delaunay triangulation.

The top-BESS vector resonance triplet confronted with the LHC measurements

Mikuláš Gintner, Josef Juráň

In the light of up to date LHC findings models of strongly interacting electroweak symmetry breaking remains viable alternative for physics beyond the Standard model. Composite degrees of freedom accompanying strong scenarios could be discovered in upcoming LHC runs. Their phenomenology can be effectively decribed by the formalism of effective Lagrangians. Recently we have formulated such an effective Lagrangian, nicknamed as "the top-BESS model", desribing a hypothetical $SU(2)_{L+R}$ triplet of vector resonances with specific direct couplings to the third quark generation. Here, we present the confrontation of the top-BESS model predictions with the findings of the LHC detectors obtained in LHC's run-1.

Morphologies and proliferation of rat mesenchymal stem cells (rMSCs) after internalization of SPIO nanoparticles investigated by various microscopic techniques

Markéta Havrdová (Svatáková), Kateřina Poláková, Josef Skopalík, Klára Šafářová, Radek Zbořil

Stem cell therapy is nowadays one of the most promising treatments in regenerative medicine. For advanced cell-based therapy is necessary to monitor the spatio-temporal distribution of transplanted cells in the target organs or in whole body. For this purpose, the stem cells must be labeled by a contrast agent to be recognized in a magnetic resonance (MR). Superparamagnetic iron oxides nanoparticles (SPION) are the most effective contrast agents for in vivo non-invasive visualization of stem cells by MRI (Magnetic Resonance Imaging). Thus, extensive knowledge about interaction, adhesion and internalization of SPIO nanoparticles with stem cells and evaluation of proliferation, viability and morphology of SPIO labeled stem cells in vitro is necessary before safe clinical therapy. In this work, we introduce various advanced microscopy techniques such as light inverted microscopy with phase contrast, fluorescence microscopy, electron microscopy and atomic force microscopy as unique tools for the complex in vitro study of SPIO labeled stem cells. Acknowledgments: The authors acknowledge support from the Operational Program Research and Development for Innovations – EuropeanRegional Development Fund (CZ.1.05/2.1.00/03.0058) and Operational Program Education for Competitiveness – European SocialFund (CZ.1.07/2.3.00/20.0058 and CZ.1.07/2.4.00/17.0084) of theMinistry of Education, Youth and Sports of the Czech Republic, andprojects funded by the Ministry of Education, Youth and Sportsof the Czech Republic (Project No. LM2011017), and Ministry ofHealth of the Czech Republic (Project No. NT11137). This work was further supported by student projects (IGA PrF 2014 023 andIGA PrF 2014 017) of Palacky University in Olomouc. The authorsare grateful to Klára Šafářova (Regional Centre of Advanced Technologies, Faculty of Science, Palacky University in Olomouc, CzechRepublic) for providing the EDS spectra.

Radioluminescence and photoluminescence of InGaN/GaN multiple quantum well nanoheterostructure

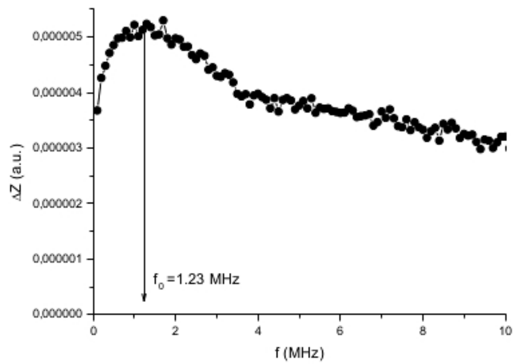
Eduard Hulicius, Alice Hospodková et al.

InGaN/GaN multiple quantum well (MQW) structure were prepared by metal-organic vapour phase epitaxy and characterize it by fine XRD measurements. We demonstrate its suitability for scintillator application including a unique measurement of wavelength-resolved scintillation response under nanosecond pulsed soft X-ray source in extended dynamical and time scales. The photoluminescence and radioluminescence were measured: we have shown that the ratio of the intensity of quantum well exciton luminescence to the intensity of the yellow luminescence (YL) band I(QW)/I(YL) depends strongly on the type and intensity of excitation. Slower scintillation decay measured at YL band maximum confirmed the presence of several radiative recombination centres responsible for wide YL band, which also partially overlap with the QW peak. Further improvements of the structure are suggested, but even the presently reported decay characteristics of the excitonic emission in MQW are better compared to the currently widely used single crystal YAP:Ce or YAG:Ce scintillators. Thus, such a type of a semiconductor scintillator is highly promising for fast detection of soft X-ray and related beam diagnostics.

The frequency dependence of the impedance caused by a single domain wall displacement in cylindrical magnetic wire

Mária Kladivová, Ján Ziman, Viktória Šuhajová

The giant magneto-impedance (GMI) effect in Co-based amorphous cylindrical wires has been subject of many studies and it has already found numerous technical applications. In present work, the results of the study of a single magnetic domain wall contribution to impedance due to its motion in intermediate frequency region (100 kHz–a few MHz) are presented for a domain wall between circular domains. A simple theoretical model of the wall trapped in a quadratic potential well, for which possible influence of skin effect is tested using the model with scalar permeability, is proposed. It follows from this model that



Figuge 2

the frequency dependence of a domain wall contribution to the impedance exhibits a single maximum for the frequency of an AC current equal to the natural frequency of the domain wall moving in a quadratic potential well. It also follows from this model that, for parameters of the wire used in experiment, skin effect only slightly influences net force acting on the wall for relative transverse permeability lower than 100 and for current frequencies lower than 3 MHz. Characteristic frequency dependences of domain wall contribution to the impedance with a single maximum have been experimentally obtained on an amorphous $Co_{68.2}Fe_{4.3}Si_{12.5}B_{15}$ wire with nominal diameter of 125 μm prepared using in-rotating-water-quenching technique after the following treatments. When tensile and torsion stresses were simultaneously applied on the as quenched wire domain structure consisting of a great number of circular domains was created. When tensile and torsion stresses were simultaneously applied during thermal treatment of the wire a small helical anisotropy was induced and domain structure consisting of two circular domains separated by a single domain wall could be created by applied inhomogeneous magnetic field. The difference between impedance before and after removal of these domain structures gives characteristic frequency dependences of domain wall contribution with a single maximum in the frequency range of 1–2 MHz [1]. Finally the wire was current-annealed under application of tensile stress. Influence of torsion stress during treatment was minimized. In this way a well-defined circular anisotropy was induced. A single domain wall could be created and manipulated in a similar way as reported in [2]. The difference between impedance of a part of the wire when the wall was present and after its displacement from this part of the wire for different frequencies is shown in Fig. 2. As can be seen a single maximum is observed at frequency of 1.23 MHz. This work was supported by the Slovak Research and Development Agency under contract No. APVV-0027-11 and also by VEGA grant No. 1/0778/12. References: [1] J. Ziman, V. Šuhajová, M. Kladivová, sent for publication. [2] J. Ziman„ M. Kladivová, B. Zagyi, J. Magn. Magn. Mater. 234 (2001) 529.

Nuclear methods in the characterization of high corrosion resistant steel

Tomáš Kmječ, Adriana Lancok, Milan Štefánik, Ľubomír Sklenka, Marcel Miglierini

High hardness and wear resistance of LC 200N steel suggest its possible perspective applications in nuclear installations. In order to understand structural arrangement and the role of the alloying elements, we have employed numerous characterization techniques. Mössbauer spectrometry was chosen as a principal method of investigation. Surface as well as bulk properties were studied using CEMS (Conversion Electron Mössbauer Spectrometry) and transmission techniques. The former method is sensitive to the depths of about 200 nm and that is why it is suitable for analyzing subsurface regions. Complementary information on these regions was obtained by SEM (scanning electron microscopy). Composition of the samples was checked by micro X-ray fluorescence (XRF) and by neutron activation analysis (NAA). Samples were investigated both in the as-prepared state, i.e. after electro-erosive cutting from original ingots as well as after surface polishing. Surface contamination by the products of cutting was unveiled. Presence of such elements as Zn, Cu, and As is observed. They do not belong to the alloy constituent elements but are products of the cutting process. After surface polishing, only the 'bulk' composition of the alloy is observed. Significant differences between surface and bulk regions are found also by Mössbauer spectrometry. While the material's bulk shows presence of martenzite-type magnetically active phases only, substantial contribution of central paramagnetic component is found in the surface layers. After a consequent removal of the affected layers, the original structural and magnetic characteristics of the base material were resumed. Financial support of the grant GACR 14-121449S is acknowledged.

Effective labeling of human fibroblasts by SPIO nanoparticles using low-intensity ultrasound

Mary Kolářová, Kateřina Poláková, Kateřina Tománková, Markéta Havrdová, Zdenka Marková, Radek Zbořil

Nowadays, in cell therapies in-vivo monitoring of target cells has become highly desirable. For this purpose SPIO (Superparamagnetic Iron Oxide) nanoparticles are suitable as magnetic detectable markers of the transplanted cells by using non-invasive magnetic resonance imaging (MRI). To improve the labeling efficiency of cells by SPIO various methods such as using transfection agents or electroporation have been used, however with some impact of cell viability. In this study we introduce a low-intensity therapeutic ultrasound as a safe and non-invasive method for cell labeling by SPIO nanoparticles. The human fibroblasts alone and with addition of SPIO nanoparticles were treated by commercial low-intensity ultrasound (BTL 4000, USA). By changing parametres such as intensity (from 0.1 to 2 W/cm^2) and exposure time (1, 3 and 5 minutes) of ultrasound and using various SPIO concentrations we have found the optimal labeling protocol having minimal impact on cell viability and maximal MRI contrast effect. The final parameters were achieved as 0.1 W/cm^2 of ultrasound intensity, with frequency of 1 MHz, 1 minute of exposure time and 500 ug/mL of SPIO as a starting concentration. The cellular uptake of SPIO was detected by Prussion blue staining and by atomic absorption spectroscopy (AAS). The viability of cells was determined by using MTT test. Contrast effect of labeled cells was confirmed by clinical 1.5 T MRI. These results suggest that the low intensity ultrasound after optimization of parameters can be used as a highly effective and non-toxic technique for labeling of cells by SPIO nanoparticles.

Study of azimuthal anisotropy of hadron production via Monte Carlo simulation

Renata Kopečná

The quark-gluon plasma (QGP) is very hot and dense form of matter, where quarks and gluons are deconfined. QGP can be produced in high-energy nuclear collisions, studied in facilities such as Relativistic Heavy Ion-Collider (RHIC) or Large Hadron Collider (LHC). Important means in the studies of QGP properties are anisotropies of the transverse flow. Transverse flow can be studied also using Monte-Carlo simulations. We present simple Monte Carlo toy model which generates hadron distributions with azimuthal anisotropy. It is used in designing analysis tools for the anisotropy coefficients.

Influence of Heat Treatment on Magnetic Properties of Amorphous Ferromagnetic $Fe_{40}Ni_{38}Mo_4B_{16}$ Microwires

Eva Komová, Filip Šidík, Rastislav Varga

The evolution of the structure of the annealed amorphous ferromagnetic $Fe_{40}Ni_{38}Mo_4B_{16}$ microwires and its interplay with magnetism has been studied. Nanocrystalline $Fe_{40}Ni_{38}Mo_4B_{16}$ microwires were obtained from amorphous precursors after heat treatment at 700 K. Their stucture consists of γ-(Fe,Ni) nanocrystals, having diameter of about 10 nm, embedded in residual amorphous matrix. It has been shown that nanocrystalline microwires exhibit much higher stability and very good soft magnetic properties. This can be used in many applications like magnetic sensors of temperature, mechanical stresses, magnetic field, etc.

Models of GMI effect in ferromagnetic microwire

Jozef Kravčák

Presented contribution brings a brief overview of recent theoretical models dealing with giant magneto-impedance (GMI) effect in a ferromagnetic microwire. Irreversible magnetization processes on the wire surface: magnetization rotation, formation of a domain structure around local surface defects and domain wall displacement are analysed in the model.

Structure changes in transformer oil based magnetic fluids in magnetic field

Jozef Kúdelčík, Peter Bury, Štefan Hardoň, Peter Kopčanský, Milan Timko

Magnetic fluid in the presence of external magnetic field can consist of individual magnetic nanoparticles, dimers and higher oligomers, chains, clusters and their various combinations. These structures can study by acoustic spectroscopy, because they interact with acoustic wave and cause its additional absorption. The observed changes in the acoustic attenuation were significant in the magnetic fluid subjected to a jumped magnetic field for given time. From the development of acoustic attenuation during the time period, the processes during the measurement can be characterized. After the magnetic field removal, the decrease of absorption coefficient depends on the lifetime of nanoparticle structures. However, the temperature of magnetic fluids has also very important influence on the structural changes because of the mechanism of thermal motion that acts against the cluster creation.

Improvement of stability of platinum catalyst for hydrogen fuel cells

Miroslava Lacková, Vladimír Komanický

Ecologically clean hydrogen powered engines are one of the possible alternatives to the modern internal combustion engines. The chemical reaction in hydrogen fuel cell (HFC) is controlled by catalysts. Nowadays, platinum and Pt-alloys are the best catalysts for HFC due to their unique chemical and physical properties. Platinum cost is the main problem hindering the mass production of HFC. That is why it is required to develop catalyst materials which use less platinum and with improved stability. Catalysts degradation due to substrate oxidation is one of the main problems in HFC. We tested corrosion stability of platinum metal deposited on two substrates. We tested glassy carbon and glassy carbon modified with titanium nitride. Both materials show high resistance toward oxidation, which should increase also stability of platinum catalyst. We performed accelerated stability test emulating fuel cell in operation. Platinum catalysts deposited on these substrates show higher stability than traditional catalysts deposited on VULCAN XC72 carbon black.

The Relativistic Mean-Field Calculations of the Properties of Light Atomic Nuclei

Jozef Leja, Štefan Gmuca

The paper deals with the calculations of the properties of light atomic nuclei. The calculations have been performed in the framework of the relativistic mean field theory with various model parameterizations. The results of the calculations have been compared with the experimental results.

EUV ablation of PPEES

Chiara Liberatore, A. Bartnik, L. Pina, L. Juha, A. Endo, T. Mocek

Preliminary investigation is presented on short-wavelength ablation mechanism poly(1,4-phenylene sulfone ether ether-sulfune) by EUV radiation a 10.8 nm obtained at WAT, in Warsaw, by a 10-Hz laser-plasma SXR source based on the double-stream gas-puff target irradiated with the 3-ns/0.8 J Nd:YAG laser pulse was used. The goal of this measurement is to verify the possibility to ablate PPEES by non-monochromatic EUV radiation and to establish the behavior of the polymer during exposition.

Photoelectric transport properties of BiOX (X = Cl, Br, I) semiconductors

Dmytro Lotnyk, V. Komanicky, V. Bunda, A. Feher

In this work transport properties of photosensitive semiconductors bismuth oxyhalides BiOX (X = Cl, Br, I) single crystals were investigated. We chose these compounds for since they exhibit promising magnetooptical properties and are good substrates for both low temperature superconductor (Nb) and high temperature superconductor (YBa2Cu3O7-δ) thin films. We experimentally obtained temperature dependences of resistivity for BiOX single crystals without laser excitation and under laser excitation. We used lasers with wavelength 532 nm (or 2.33 eV) and 640 nm (1.93 eV); and measurements were performed in a in-plane and out-of-plane geometry; at a zero and 1T magnetic fields. The most promising results were obtained for BiOI sample under both 532 nm and 640 nm laser excitations. For this sample metal-insulator transition was observed. Such behavior could be explained by the lowest indirect energy band from all three studied semiconductors gap (Eg BiOI = 1.85 eV; Eg BiOBr = 2.76 eV; Eg BiOCl = 3.44 eV) and the lowest Debye temperature $\theta_D = 146$ K ($\theta_D = 168$ K for BiOBr and 205 K for BiOCl). Transition temperatures $T = 160$ K under 532 nm and $T = 110$ K under 640 nm excitation could be useful for investigating transport properties of photosensitive semiconductor/high temperature superconductor (e.g. YBa2Cu3O7-δ) heterostuctures under laser excitation. Low resistivity behavior under green laser excitation in BiOI sample were observed down to 4 K which allows to investigate transport properties of photosensitive semiconductor/low temperature superconductor (e.g. Nb) heterostuctures under green laser excitation. Keywords: photoconductivity, metal-insulator transition, BiOX (X= Cl, Br, I) semiconductors

Lithium doped Single-walled carbon nanotubes

Bence Gábor Márkus

The poster presents both the chemical synthesis and electronic behavior of Lithium doped SWCNTs. Electron Spin Resonance and Raman spectroscopy were used to characterize the nanotubes and to optimize the sample preparation. Electronic conductivity measurements were also made. It is observed that a new feature appeared in the ESR spectra with a linewidth of about 1.7 mT. Furthermore, the $G-$ and $G+$ peaks are shifted by about $15\,\mathrm{cm}^{-1}$ and $5\,\mathrm{cm}^{-1}$ respectively in the Raman spectra. The conductivity measurements showed that the Li-doped samples have metallic behavior while the pristine samples are semiconductors.

Spin-relaxation in doped bilayer graphene

Lénárd Szolnoki

The rapid development of microprocessors and electronic circuits predicts that the devices will reach the physical limits of the conventional electronics. As a result, dramatically new approaches are required to be able to further improve the computing speed and storage capacities. One possible solution can be the use of spintronics. It is a challenge already to find an appropriate material which can be used for building circuits that can utilize the principles spintronics. Graphene seems to be a promising candidate for this since it can endure much larger electronic fields than ordinary metals. This way it is possible to induce collective spin-currents. However there are varying predictions for the spin-relaxation time in graphane in the literature. This issue motivated the research which is presented here. I particularly investigate the bilayer graphene. Based on the symmetries I derive the most general form of the spin-orbit coupling then I derive the spin-relaxation time.

CERN programme for high-school teachers

Miriam Šimralová

In this contribution the experiences from the participation in the CERN education programme are given. Among the major missions of CERN is education, and one of the efficient ways to achieve it is to “teach the teachers”, as they then will bring back to the schools their knowledge. Two types of programme are organized at CERN for high-school physics teachers: National teacher programmes are run in the participants’ mother tongue and the lectures are usually given by the physicist from the corresponding member state. All member states, and even some non-member ones, are using this possibility to send their teachers to CERN. The second option is a three-week comprehensive course held in English at the beginning of summer, called High-School Teachers’ (HST) programme. In addition to education in physics, the HST goals are: to promote the exchange of knowledge and experience among teachers of different nationalities, to expose teachers to the world of research, and to stimulate activities related to the popularization of physics within and beyond the classroom. All lectures are archived and openly accessible, providing an invaluable resource for teachers and students.

Effect of magnetic fluid layer thickness on the spectral transmittance

Norbert Tarjányi, Marek Mlynarčík

Magnetic fluid found its first major commercial application in the 60s of the 20th century as part of the rocket fuel. The idea was to control the transfer of the fuel in condition of a weightless environment by means of a magnetic field. Since then a lot of interesting applications in electronics, electrical engineering, material science, medicine or even optics has emerged utilizing these colloidal suspensions consisting of solid magnetic nanoparticles dispersed in a carrier fluid. This paper presents the results of the investigation of spectral transmittance of the magnetic fluid layer depending on its thickness. The achieved results are interpreted in terms of the possibility of using magnetic fluid layers with different thicknesses as optical filters.

Viscosity effect on Hyperthermic properties of various Oil-Based Magnetic Fluids

Milan Timko, Matus Molcan, Peter Kopčanský, Jana Tothova,
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The heating ability of magnetic fluids based on various transformer oils with different viscosity at the same concentration of magnetite was studied. The calorimetric measurements were carried out in an alternating magnetic field up to 5 kA/m amplitude and of 500 kHz frequency. The revealed H^{n} law-type dependence of the temperature increase rate $(\mathrm{d}T/\mathrm{d}t)_{t=0}$, on the amplitude of the magnetic field indicates the presence of superparamagnetic nanoparticles in the tested samples since $n = 2$ for all samples. The specific absorption rate (SAR) defined as the rate of energy absorption per unit mass increases with a decreasing of carrier liquid viscosity. So it can be concluded that Brownian relaxation takes the main part in process of sample heating in ac magnetic field at frequency 500 kHz. Suported by ME SR Agency for Structural Funds of EU projects No. 26110230097, 26220120046 and 26220220061 and Project VEGA 0043.

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