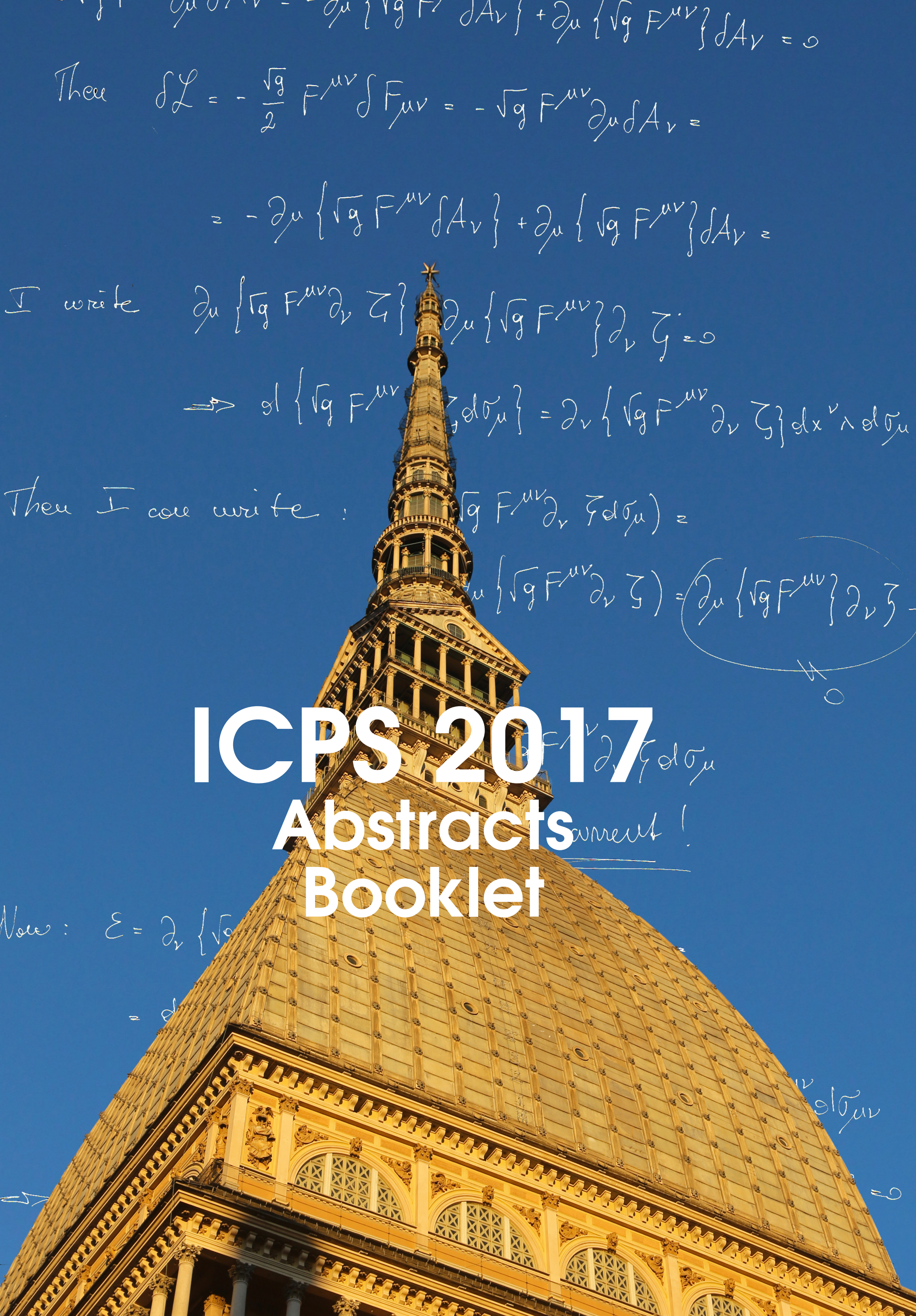
ICPS 2017 Abstracts Booklet



Welcome Address

Dear participant,

With nearly 200 contributions, the 32nd International Conference of Physics Students boasts one of the richest scientific programs ever.

We are very excited to get to know you and to hear about your cutting-edge research, which spans nearly every subfield of physics. ICPS is the perfect setting to talk to your peers about the results of your studies and research in an environment where scientific rigor is expected but formalities are set to a minimum. For many, an ICPS is the first occasion to present results outside of their research group. If this is indeed the case, cherish the moment and go all out!

We are sure you'll find many talks and poster presentations which will stimulate your interest and curiosity. Don't forget to follow up with questions and discussions, maybe at dinner over some delicious food and wine! The exchange and discussion of ideas is of paramount importance for any scientific undertaking and it is at the very heart of ICPS too. During the 32nd edition, we hope to reach new highs in terms of intellectual engagement and participation.

You'll make that happen!

The XXXII ICPS Organizing Committee

Practical Information

Talks

Parallel sessions dedicated to oral presentations will take place in the morning (9:30-11:00) of August 10, 12 and 13 as well as in the afternoon (15:00-16:30) of August 13. During each time slot, five different parallel sessions, i.e. five different presentations, will be taking place. Each presentation will last 12 minutes, with 3 extra minutes allocated for questions. The parallel sessions will take place in rooms A1, A2, A3, B1 and B2. The specific location of the rooms can be seen on the map below. You can find information about the time and location of any presentation both in the table on the following pages and next to each abstract in this booklet. At the end of this booklet you'll also find an author index which should help you retrieve quickly information about presentations you would like to attend.

Oral presentations will take place in rooms A1, A2, A3, B1 and B2 while the Main Hall and adjacent corridors will be used for the poster sessions.

Poster Presentations

Two formal poster sessions will take place on August 8 (11:30-13:00) and on August 13 (17:00-19:00).

Every student presenting a poster should illustrate their work during both sessions. This is to ensure that your work has the highest possible visibility and at the same time to allow other participants to explore different concepts and ideas in depth.

In fact, the posters will hang in the Main Hall and adjacent corridors throughout the week (from the beginning of the first poster session until the end of the second), thus allowing multiple iterations of observation and analysis.

Talks Timetable

On the following pages you'll find a detailed timetable of all oral presentations.

You will notice that your presentations have been organized according to their subfield. As any classification procedure, this organization is rather rigid and we were forced to make a choice for many abstracts which sit at the edge of different areas. In some instances the choice was dictated by organizational as well as scientific purpose.

If you have any questions or concerns please do not hesitate to get in touch with us at scientific-committee@icps2017.it.

August 10, 9:30-11:00

Room Number **Topic(s)**	**A1** **Other Interesting Topics**	**A2** **Complex Systems**	**A3** **Quantum Physics and Technology**
9:30-9:45	Raimundo Sieso Ortiz	András Sárádi	Maria Gieysztor
9:45-10:00	Yannick Linke	Shahab Bahreini Jangjoo	Marco Canteri
10:00-10:15	Cecilia Meneses-Ponce	Bálint Kaszás	Dominik Rattenbacher
Topic(s)	**Other Interesting Topics**	**Fluid Dynamics**	**Quantum Physics and Technology**
10:15-10:30	S. Cako and O. Vujinović	Tomasz Bonus	Giovanni Scala
10:30-10:45	Bellona Bles	Abhishek Gupta	Filip Sośnicki
10:45-11:00	Bishal Banjara	Giorgi Tsereteli	Lamborghini Sotelo

Room Number **Topic(s)**	**B1** **Biophysics and Medical Physics**	**B2** **Materials and Solid State Physics**
9:30-9:45	Judit Börcsök	Abderrahim Ait Raiss
9:45-10:00	Lia Meladze	Maximilian Paleschke
10:00-10:15	Adrian Salo	Jannis Dickmann
10:15-10:30	Juan Prieto-Pena	Christina Nolte
10:30-10:45	Jenny Yang	Tom Dumont
10:45-11:00	Ana Jorge Gonçalves	Anton Saressalo

August 12, 9:30-11:00

Room Number **Topic(s)**	**A1** **Theoretical Physics**	**A2** **Particle Physics**	**A3** **Environmental and Atmospheric Physics**
9:30-9:45	Kasia Budzik	Goran Jelic-Cizmek	Wiebke Hahn
9:45-10:00	Mihály Máté	Baptiste Ravina	Binod Bhattarai
10:00-10:15	Mikheil Sokhashvili	Bianka Meçaj	Issam Bouganssa
Topic(s)	**Theoretical Physics**	**Particle Physics**	**Astrophysics and Space Physics**
10:15-10:30	Jan Peter Carstensen	Alexandra Neagu	Anastasiya Annenkova
10:30-10:45	Valeriya Mykhaylova	Nicholas Deporzio	Erik Johnson
10:45-11:00	Julia Lange	David Hegedus	Özgür Can Özüdoğru

Room Number **Topic(s)**	**B1** **Biophysics and Medical Physics**	**B2** **Materials and Solid State Physics**
9:30-9:45	Ildikó Stark	René Hamburger
9:45-10:00	Stuart Crane	Tomasz Szołdra
10:00-10:15	Oana Daciana Botta	Enrico Stein
10:15-10:30	Evelin Berekméri	Marko Shuntov
10:30-10:45	Ana Milinović	Zamin Mamiyev
10:45-11:00	-	Dewan J. Woods

August 13, 9:30-11:00

Room Number **Topic(s)**	**A1** **Theoretical Physics**	**A2** **Particle Physics**	**A3** **Astrophysics and Space Physics**
9:30-9:45	Michał Dragowski	Saverio Mariani	Fraser Pike
9:45-10:00	Adrian Solymos	Tamas Almos Vami	Alexandru Nistorescu
10:00-10:15	Aleksandra Sroda	Timo Eckstein	Gabriella Zsidi
10:15-10:30	Daniel Blixt	Oliver Lantwin	Kristóf Rozgonyi
10:30-10:45	Dániel Németh	Ariel Matalon	Sabrina Gronow
10:45-11:00	Manik Dawar	-	Sándor Kunsági-Máté

Room Number **Topic(s)**	**B1** **Materials and Solid State Physics**	**B2** **Materials and Solid State Physics**
9:30-9:45	Nikodem Stolarczyk	Bettina Leibundgut
9:45-10:00	Benjamin Wolba	Jacqueline Marie Börgers
10:00-10:15	Adrián Costa Boquete	Veera Juntunen
10:15-10:30	Péter Nagy	Sofia F. Teixeira
10:30-10:45	Freek Broeren	Octavian-Gabriel Simionescu
Topic(s)	**Nuclear Physics**	**Materials and Solid State Physics**
10:45-11:00	Joanna Peszka	Michael Pusterhofer

August 13, 15:00-16:30

Room Number	**A1**	**A2**	**A3**
Topic(s)	**Other Interesting Topics**	**Computational Physics**	**Quantum, Materials, Solid State**
15:00-15:15	Dominik Utz	Grzegorz Lukas	S. Gombar and N. Micić
15:15-15:30	Monika Schied	Robert Poenaru	Piotr Gładysz
Topic(s)	**Physics Education**	**Computational Physics**	**Quantum, Materials, Solid State**
15:30-15:45	Karel Kolář	Gábor Péterffy	Petrisor Gabriel Bleotu
15:45-16:00	Maria Katsiampa	Joona Havukainen	Tobias Messer
16:00-16:15	David Jacome	Benedek Horváth	Sascha Ranftl
Topic(s)	**Complex Systems**	**-**	**Quantum, Materials, Solid State**
16:15-16:30	Anmol Lamichhane	-	Andre Sobotta

Room Number	**B1**	**B2**
Topic(s)	**Astrophysics and Space Physics**	**Materials and Solid State Physics**
15:00-15:15	Jacqueline Catalano	Robert Rauter
15:15-15:30	Greg Anderson	Biljana Mitreska
15:30-15:45	Nikola Stupar	Tetiana Rokhmanova
15:45-16:00	Jussi Hedemäki	Viktor Könye
Topic(s)	**Astrophysics and Space Physics**	**Plasma Physics**
16:00-16:15	Philip Sørensen	Lilla Vanó
16:15-16:30	-	Bogdan Butoi

Contents

Talks

Astrophysics and Space Physics

Concept of Volatile Organic Compounds Analyzer for ISS Atmosphere Monitoring

12 Aug
10:15am
A3

Anastasiya Annenkova

Moscow Institute of Physics and Technology

International Space Station (ISS) Atmosphere is an isolated and regenerated, as a result atmosphere contains many volatile organic compounds (VOC). For example, compounds such as ammonia, Freon or formaldehyde have a great negative impact on astronaut's health. Therefore, a lot of timely control on them in the atmosphere is required. Nowadays, astronauts have special absorbents for accumulation of harmful substances while they are in the ISS. After the homecoming of astronauts, the absorbents were explored in the specialized laboratories using gas chromatography and mass spectrometers. The accuracy of these methods is high, but their complexity and the need for maintenance don't allow them to be used in the orbit. The aim of this paper is the development of the ISS atmosphere monitoring system. Spectrometric methods are the most useful for solving this problem. The main problem is that the spectra of heavy organic molecules are not resolved and overlapped. Therefore, it's necessary to provide a wide spectral range (8-11μ) to effectively identify individual compounds. Usually this task is solved by Fourier spectrometers.

But Fourier spectrometers, which can be used in the orbit, has too low spectral resolution (0,5 cm^{-1}) to resolve individual narrow spectral features. In this paper we propose to use cavity enhanced laser spectroscopy method using cavity quantum-cascade laser (EC-QCL). Modern quantum-cascade lasers can provide a wide spectral range (8-11μ) for hundreds of milliseconds. The laser line width doesn't exceed a few megahertz, which provides a high spectral resolution (<0,001 cm^{-1}). It is also important to accurately measure the absorption of the continuum due to the overlapping of the compounds spectrums over the entire spectral range. These are the reasons we are going to use cavity ring-down spectroscopy (CRDS) with an effective optical path of 140-280 meters depending on the spectral range. It is early stage project and we present an optical and general scheme of spectrometer, sensitivity estimates and dynamic range on the conference.

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12 Aug
10:30am
A3

Overview of the State of Research in the Field of Exoplanets

Erik Johnson
University of Göttingen

In the last 20 years, since the discovery of the first exoplanet around a main sequence type star, there has been a great period of discovery of new planets. Many of these planets are of types that had not even been considered before their discovery and do not exist within our own solar system. Some of these, such as Hot Jupiters, exist in areas of their systems that they could not have formed in and has resulted in additional research and understanding of how planetary systems form. These planets have been discovered by an ever increasing variety of methods. The first, and still most used, method was that of high precision radial velocity measurements of the planet's parent star. The second, most popularized by NASA's Kepler mission, is the transit method. This method observes a star for a long period of time to see the periodic luminosity decrease of a planet moving in front of the star. Other methods include gravitational microlensing, direct imaging and astrometry. Each method has a particular set of planets that is ideal for detection and reveals differing information about these planets once discovered. Additionally each of these methods can be affected by differing characteristics of the observed star such as stellar activity influence on precision radial velocity measurements. Taken together these factors have lead to a very informative distribution of discovered planets that still has significant observational biases. It is the hope of everyone in the field that upcoming missions and surveys, such as GAIA, JWST and CARMENES, will help to close some of these gaps and give us a better picture of the planetary distribution in our galaxy. Additionally in the last year there have been some major discoveries concerning potentially Earth-like planets in the solar neighborhood.

HabSim (Habitability Simulator)

12 Aug
10:45am
A3

Özgür Can Özüdoğru
Middle East Technical University

In this study, we have written a program which determines the range of the habitability zone of a star when given the Star Type as an input. Program shows the range of the Habitability region and also when the user introduces planets revolving around the star that stated, before, our program plots the location and the 2D simulation of that star system and shows how many planets are in the region of Habitability. We have designed it to be an open source program so that future work can be done by others.

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13 Aug
9:30am
A3

Photonic Lanterns: a breakthrough in spectrograph design

Fraser Pike

Heriot-Watt University

As telescopes continue to increase in size, the need for fibre fed spectrographs is strengthened. High precision measurements such as the radial velocity technique can be affected by modal noise in the fibre, causing lower than ideal resolving power. The hybrid reformatter is a device, containing a photonic lantern, which takes the multimode point spread function of the telescope and converts it into a diffraction-limited slit of single modes, where modal noise should be absent. Unfortunately, this is not the case, and I will demonstrate the spectrograph I have constructed to characterise the modal noise. This spectrograph can also show how agitation of the fibre can decrease the level of noise.

Use of Virtual Reality applications in astronauts training and other space-related activities

13 Aug
09:45am
A3

Alexandru Nistorescu
University of Pitesti

In the last few years, the use of virtual reality technology developed in an accelerated rhythm from one day to another and in the present it offers new viewpoints on training and education. What the new visual immersive VR concept is actually doing is to place a person in a simulated environment that looks and reacts, up to a point, as the real world. Astronauts always reported disorientation and spatial memory difficulties while in space, mainly because they orientation in space is based mostly on visual, because the usual terrestrial cues to the vestibular organs are absent. As a result they usually routes as a sequence of memorised landmarks and turns but this method fails in case of reduced visibility. Using VR and a 3D representation of the spacecraft subjects train in different visibility conditions in order to be able to develop new orientation skills under new conditions. Another use of VR headset is to counteract space motion sickness reported by astronauts during spaceflight, which is another effect of orientation difficulties and vestibular system. In the present, what we are trying to do, using immersive VR and EEG headset is to place the subjects in different hazardous situations on the spacecraft and record their brain activity and capability to react in a proper way and control the situation. This type of exercise can serve in the future as a selection tool for space missions in order to identify the suitable subject for the task.

13 Aug
10:00am
A3

Temporal Evolution of Sunspot Groups

Gabriella Zsidi

Eötvös Loránd University

Sunspots are regions in the solar photosphere which have reduced temperature compared with their surroundings, making them appear dark when viewed in white light. A sunspot group typically consists of one or more compact spots. I used the daily records of sunspot groups from the last 150 years in order to examine their temporal evolution, but I only included data when they satisfied the preset selection criteria. The variation of the sunspot groups' area was approximated with the skew normal distribution and I examined the relationship between the paramters of the distribution. The parameters of the best fit model were determined with the Marcov-Chain Monte Carlo method. The results show that the value of the n parameter, that indicates the asymmetry of the evolution of sunspot groups, is zero or around zero in the most cases, i. e. the evolution is nearly symmetric. In the case of asymmetric evolution, the majority of the n values are positive, i.e. the tail on the decay side is longer than on the growth side. The examination of the temporal variation of the n parameter shows that there is no preferred period or location of appearance, where the symmetric evolution is more frequent.

Looking for precessing quasar jets using high-resolution VLBI observations

13 Aug
10:15am
A3

Kristóf Rozgonyi

Eötvös Loránd University

The innermost structure of radio-loud active galactic nuclei (AGN) can be directly studied with the technique of very long baseline interferometry (VLBI). High-resolution VLBI imaging observations reveal the geometry and the physical properties of relativistic jets emanating from the vicinity of the accreting central supermassive black holes. The physics of the jets is not fully understood yet, thus the discovery of kinematically special, new sources is required to better understand the nature of jets.

Complementary VLBI observations of geodetic surveys are providing many sources with unique, long-term observational history. The International Celestial Reference Frame (ICRF) currently has nearly 300 defining objects which are mainly quasars. The ICRF was redefined in 2009 (ICRF2) and its list was extended with new sources. However, there were 39 defining objects of ICRF1 which were left out from the second realization as they showed long-term positional instability. Nevertheless the VLBI observations of some of these sources have never been examined in the framework of jet kinematics.

In my presentation I will show the results of my analysis of the astrometric data of the 39 special handling sources and the kinematic analysis of the VLBI imaging observations for one selected source.

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13 Aug
10:30am
A3

Sub-M_{Ch} white dwarfs as SN Ia progenitors

Sabrina Gronow
University of Heidelberg

Supernovae are the main contributers of iron in our galaxy and influence the galactic chemical evolution. The moving mesh code AREPO allows a parallel treatement of the occuring hydrodynamics and a nuclear network. It is used to simulate the double detonation of a sub-Chandrasekhar mass white dwarf as a possile progenitor of a Type Ia supernova. Different initial models are analysed for their evolution and final abundances in one and three dimensional simulations. An explosion in a double detonation scenario can lead to spectra and light curves that are in agreement with observations and thereby it can give an insight into the origin of the elements in our galaxy.

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13 Aug
10:45am
A3

Investigation of the limb darkening coefficients by modelling the transit light curves of eclipsing binary stars

Sándor Kunsági-Máté
Eötvös Loránd University

The so-called transit method is one of the most powerful tools of the exoplanet research. During a transit the planet causes a decrease in the light intensity of its host star what we can measure directly. Nevertheless a lot of other factors can also cause a change in the intensity-time diagram. Such a factor is the limb darkening, which is related to the intensity distribution of the star. To reconstruct this phenomenon there were created many stellar atmosphere models. However there was found that the light intensity predictions of them don't

match to the observations, and they often contradict to each other. These uncertainties can significantly influence the parameters of exoplanets derived from transit method. The error of the derived radius of the planet can be even 20%!

Regarding to these inconsistencies, the need has arised to specify the limb darkening laws. During my work I have modelled the transit light curves of eclipsing stars observed by CoRoT space telescope, and I have determined the limb darkening coefficients for some binary systems using the four-parameter limb darkening law. The final goal of the project is to create an empirical law that reconstructs the correct behaviour of the limb darkening.

Gamma-Ray Astronomy in the Lecture Hall

13 Aug
3:00pm
B1

Jacqueline Catalano
Friedrich-Alexander-Universität Erlangen-Nürnberg

Cosmic ray physics became increasingly more advanced since its discovery by Viktor Hess in 1912. Very high energetic gamma-ray radiation is produced by cosmic rays arising from a number of different sources in the universe. Examples for such sources are active galactic nuclei or supernova remnants. Giving students the unique opportunity to get experience handling a gamma ray telescope and its data, a special and innovative lecture was introduced. Like this, the students get the chance to work with an instrument that is used in research. The lecture includes observation nights with the FACT-telescope located on La Palma controlling the telescope remotely from the lecture hall. Following this, the students learn how to handle and analyze real data taken at the observation nights with modern analysis techniques. Writing a report in the style of a scientific publication was a nice closure of the one-week block seminar. In this talk, I will review all the way from the introduction to ground based gamma ray astronomy with imaging air Cherenkov telescopes over analyzing steps to the interpretation of the data.

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13 Aug
3:15pm
B1

Fluctuations in the early universe

Greg Anderson

Heriot-Watt University

In the very early stages of our universe there were tiny energy fluctuations which led to the evolution and formation of the universe as we see it today. During the inflationary period when the universe expanded at an enormously large rate, the quantum fluctuations were stretched out past their event horizons where they appear to stop oscillating. When many of these fluctuations built up it created an energy landscape that was eventually responsible for the creation of stars and galaxies. This talk will explain the origin and effect of the quantum fluctuations, and show simulations and models of the evolution of the energy field during the inflationary period of time.

Complexity in Various Inertial Reference Frames

13 Aug
3:30pm
B1

Nikola Stupar
University of Banja Luka

In this paper, a new view on accelerated expansion of the universe is presented. Computational experiment was performed to simulate oscillator which was observed in two inertial reference frames (Σ and Σ'). Oscillator is a representation of rotational motion of celestial bodies in one dimension. Oscillator's equilibrium point is still in system Σ'. System Σ' is moving away from system Σ. Velocity is velocity of oscillator's equilibrium point in system Σ. Velocity of oscillator's equilibrium point in system Σ was calculated by using relativistic addition of velocities. In our approximation, velocity is increasing in steps, so that there are time intervals in which system Σ' is inertial one. Cmp complexity defined by permutation and linear combination is calculated for this series of velocity values in system Σ. Multiple plots are showing Cmp complexity for various oscillator's parameters. Cmp complexity in system Σ increases when velocity between systems increases up to speed of light c, where it peaks. Accelerating expansion of the universe is linked with arrow of time. Increasing Cmp complexity is consistent with direction of arrow of time, and it can be concluded that the universe is expanding at accelerated rate. The special case was also observed in which velocity of oscillator in system Σ was greater than speed of light c. If universe expansion would be greater than speed of light c, time and coordinates in system Σ' would become imaginary, and time in system Σ would change it's direction.

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13 Aug
3:45pm
B1

The Gaia satellite

Jussi Hedemäki
University of Oulu

In my talk I will discuss about the Gaia satellite, which was launched in 2013. The primary goal for the Gaia mission is to make the most precise 3D-map of our galaxy. Over the duration of its 5-year mission, Gaia will survey over one billion stars, and gather important information from them. The data gathered can be used to study the formation of our galaxy, back when it was young. Among many things, Gaia will help us find new planets, brown-dwarfs, quasars and supernovae. First batch of data gathered was released late in 2016, and some of it has been processed. I will use some of the data in my Bachelor's degree, and will talk about that too. I will also briefly discuss how the Gaia mission improved upon the Hipparcos mission, which launched in 1989. I have included an illustration of Gaia, which shows the modules and the sunshield.

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13 Aug
4:00pm
B1

Probing inflation with gravitational waves

Philip Sørensen
University of Southern Denmark

We will investigate how precise models of inflation can be probed through the imprint of primordial gravitational waves in the Cosmic Microwave Background (CMB). Gravitational waves are generated by quantum fluctuations during inflation, with an amplitude proportional to the energy scale of inflation, and subsequently imprinted in the polarisation of the CMB. The aim of this presentation is to understand how precise measurement of the CMB polarisation can teach us about the energy scale of inflation, and to understand the precise physics involved in how gravitational waves gets imprinted in the polarisation of the CMB. The presentation is based on a bachelor thesis written by Philip Sørensen and supervised by Martin S. Sloth of the Centre of Cosmology and Particle Physics, SDU.

Biophysics and Medical Physics

Signatures of Mutational Processes Operative in Human Cancer

10 Aug
9:30am
B1

Judit Börcsök

Eötvös Loránd University, Budapest

Today the individual fields of science do not terminate sharply from each other, rather support each other. We can use their combined knowledge and methods for tackling a wide variety of problems, for instance carcinogenesis. In this field of study physicists work arm-in-arm with biologists and computer scientists to handle and analyse a large amounts of data gained from DNA sequencing and to get a better insight into the pathogenetic mechanism underlying all cancers. The genome of a cancer cell bears somatic mutations that are the cumulative consequences of the DNA damage and repair processes operative during the cellular lineage from the fertilized egg to the full-fledged cancer cell. Global sequencing initiatives are providing catalogs of somatic mutations from thousands of cancers, thus opening the door to decipher the signatures of mutational processes operative in human cancer. Through the characterization of mutational signatures, we may shed light to the mechanisms and agents conducing to and protecting against cancer formation, which may be useful in prevention and development of more efficient treatment strategies. The talk wishes to summarize our current understanding of mutational patterns and mutational signatures and to briefly present the analytical method of deciphering the signatures of mutational processes.

G-Quadruplex as an evolving target for cancer therapy

10 Aug
9:45am
B1

Lia Meladze

Free University of Tbilisi

It is known that effectiveness on G-quadruplex DNA formation at physiological conditions depends on ligands, which recognize such sequences that form quadruplexes at presence of monovalent ions, the most effective one of which is K^+. The structure of DNA G-quadruplex in vivo is determined not only by oligonucleotide sequence but also by monovalent ions and ligand-recognizing molecules. In this work spectrometric CD and absorbtion methods were used to study the influence of anticarcinogen compound TOEPyP4 porphyrin and Co ions on a thermodynamic stability of G-qudruplex-firming sequence $GGG(TGGG)_3$. It was shown that by adding the slowly increasing concentration of TOEPyP4 porphyrin to the G3-quadruplex, it gets more thermally stable. On the other hand Co ions unfold G-quadruplex and lessen its thermal stability. Van-Hof enthalpy at various concentrations of TOEPyP4, K^+ and Co^{2+} has been determined for individual porphyrins, metals and DNA, as well as their complexes.

Free Electron Dynamics in Biological Tissue

10 Aug
10:00am
B1

Adrian Salo

University of Southern Denmark

The dynamics of a cloud of interacting free electrons in a biological medium is currently poorly understood. Such an electron cloud is known to generate free radicals which causes biodamage, or the so-called secondary electrons might bind to proteins and molecules in the nearby cells and disturb their functions. It occurs as one of the intermediary effects in ion beam cancer therapy (IBCT), but primarily it is the subsequent effects that have been investigated and modeled. In our bachelor's project, we aim to assemble and formulate a model for describing the dynamics of free electrons in a medium, specifically biological tissue. We explore what numerical codes are available, and to what extend they may provide the features needed for properly modeling the complexity arising from electron-electron interactions, and possibly electron-molecule interactions. The physics that govern the dynamics of the plasma (the electron cloud) covers a broad spectrum of fields such as medical physics, i.e. in the form of IBCT, plasma physics, biophysics, with its direct effects on cells and tumors, and computational physics.

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10 Aug
10:15am
B1

Analysis of micro-dosimetric distributions using micro-pattern silicon devices

Juan Prieto-Pena
University of Santiago de Compostela

The techniques of treating cancer using protons and heavy ions are especially effective in radio resistant tumors. The characterization of the hadron beams' radiobiological effects depends deeply on the knowledge of the microdosimetric energy deposition distributions associated to the trace structure of the ionizing beam particles. By understanding such distributions at cellular level the radiobiological efficiency or radiobiological averaged dose required for treatment planning can be calculated. New manufacturing techniques permit the construction of silicon micrometre-scale instruments for the measurement of those distributions.

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10 Aug
10:30am
B1

Identifying Functional Cluster of Genes from Energy Landscapes in Autoencoders for Personalized Therapy in Medicine

Jenny Yang
University of British Columbia

In the pursuit of personalized medicine within oncology, growing attention is being given to machine learning for cancer diagnostics and treatment. Because machine learning is at the interface of theoretical physics and high-dimensional statistics, the accuracy and success of a model may not depend on computational power or algorithm complexity. Instead, it can depend on comprehensively understanding the theoretical dynamics and energies of the data system itself. Our goal is to analyze the energy landscape of our autoencoder model, for purposes of determining which genes carry the most predictive information in classifying different cancer types. We are training an autoencoder to perform dimensionality reduction on a set of 17,688 genes in the human genome. The learning process finds weights over the training dataset that minimize a loss function. The loss function, derived from statistical physics, represents the energy of the model. The training process aims to find a global energy minimum of the system. Looking at which hidden nodes have the strongest output signal, and performing perturbation analysis of these nodes against the input genes will help us interpret predictive and discriminatory genes. While training, we adjust the activation functions (e.g. sigmoid, standard normal) and loss functions (e.g. cross-entropy, mean-squared) to better understand the energy landscape of our model, as well as the characteristics of the training dataset. Understanding the theoretical underpinnings of our autoencoder model is central to determining which genes carry the most predictive information for classifying different cancer types. This is a fundamental task in our current research towards implementing personalized therapies in cancer.

Fiber Optic Dosimeter: Study in Current and Counting Mode

10 Aug
10:45am
B1

Ana Jorge Gonçalves
University of Aveiro

In radiotherapy techniques, treatment quality is essential, which can be achieved by using *in vivo* dosimetry. In this sense, a prototype dosimeter can be used for brachytherapeutic applications, particularly for prostate cancer treatments. The dosimeter uses scintillating optical fibres, coupled with a polymethyl methacrylate (PMMA) optical fibre that guides the scintillation light toward the silicon photomultiplier. To assess its viability for dosimetry applications, we analysed components of the dosimeter and its overall behaviour. Initially, we studied the attenuation of PMMA fibres with the wavelength of the scintillation light, results of which suggested that using a scintillating optical fibre with emission in the blue region is optimal for configuring the dosimeter prototype. One advantage of this dosimeter is to permit its attachment to brachytherapeutic needles. By extension, we assessed the extent of the attenuation of *BrachyStarr* needles (by *Bard Medical*) and their qualitative composition. We evaluated the dosimeter response, in current mode and counting mode, whose behaviour was linear with the dose. On the other hand, we calibrated the dosimeter using a commercial dosimeter (*RaySafe*TM *Xi*). We also concluded that the dosimeter prototype has a higher energy dependence for the current mode and the counting mode is a more reliable and precise method.

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12 Aug
9:30am
B1

Causality Analysis of Epileptic Signals

Ildikó Stark

Eötvös Loránd University

Epileptic seizures can cause epileptic seizures in other cells and brain areas. Sometimes surgeries depend on which area is the source and which are only affected by it. My presented work addresses this question. An introduction to the Sugihara causality anaysis is given, then a model of epileptic seizures is described, finally results of both simulated and measured data are shown.

Time-Resolved Photoion Yield Spectroscopy of Non-Volatile Biological Analogues

12 Aug
9:45am
B1

Stuart Crane

Heriot-Watt University

Gas-phase spectroscopic techniques provide a valuable insight into the fundamental dynamics of biological chromophores following ultraviolet (UV) absorption, free of intermolecular and solvent effects. These rapid and efficient energy redistribution processes are believed to be vital to the understanding of biological photoprotection. Many large molecules of interest, however, have low vapour pressures, with a tendency to decompose under vigorous heating, making gas-phase spectroscopy difficult. This talk introduces a soft thermal desorption technique, incorporated within a time-of-flight mass spectrometer (TOFMS), facilitating studies of the UV-photoprotection in non-volatile model biological chromophores. Back irradiation of a thin metallic foil by a CW laser produces neutral plumes of the molecule of interest. Numerous biologically relevant molecules will be discussed, including preliminary studies on uracil and thymidine.

12 Aug
10:00am
B1

Observation of gaseous biomarkers concentrations found in human breath samples using photoacoustic spectroscopy

Oana Daciana Botta

University Politehnica of Bucharest

Breath sampling has recently gained popularity amongst the techniques used for monitoring disorders and diseases, as it is a non-invasive procedure and completely painless to patients. Efficient breath analysis techniques include various spectroscopy methods, where the signals obtained can be used for molecular identification and quantification. Studies have shown that there is a dependency between the concentrations of volatile organic compounds(VOCs), found in exhaled air, and the pathophysiological status of the body. In this paper, the chosen method is photoacoustic spectroscopy (PAS), a technique in which the analysis of elemental concentrations is directly linked to the detection of acoustic waves produced in the gas. The principle of the effect is that an absorbent gas can produce acoustic waves, when it is subjected to an incident light beam. The PAC method will specifically be used for determining the concentrations of the biomarkers ammonia and ethylene in breath samples provided by patients suffering from type 2 diabetes.

The bioelectrical signals of the brain

12 Aug
10:15am
B1

Evelin Berekméri
Eötvös Loránd University

The functioning of the brain - as the muscle and heart functions as well - is accompanied by electrical signals. Nerve cells' membrane currents are going through the intercellular space and these potential changes can be measured on the body surface by electrodes - this is the base of electroencephalography. My research aims to examine the brain's electrical activity in the manner above. The signals of the experimental subjects generated by various stimuli are recorded by an Emotiv Epoc+ detector. Thus, information is obtained in a non-invasive way, mainly from the territory of the cortex and hippocampus.

Radical pairs and magnetosenses

12 Aug
10:30am
B1

Ana Milinović
University of Vienna

First a short overview of magnetosenses in animals will be given. Secondly, ornithological indications for a photon-simulated magnetosensor in birds will be presented. Following this introduction, relation to quantum optics and entanglement will be revealed. The idea of a radical pair mechanism will be described, with proposed molecular system, and systems demonstrated as magnetosensors. How can this be studied on the single-molecule level in matter-wave interferometry will be discussed.

Complex Systems

Kolmogorov complexity, the measure of understanding.

10 Aug
9:30am
A2

András Sárádi

Eötvös Loránd University

Kolmogorov complexity also known as algorithmic entropy of a string or any mathematical object is the length of the shortest possible description of the object in some fixed universal description language. The precise definition of a description is given by an universal Turing machine. The existence of an upper limit of Kolmogorov complexity gives us a chance to approximate this quantity even though determine this quantity is an uncomputable problem in general. After a brief introduction to Kolmogorov complexity I will present its connection to the scientific method and the application of this term in the theory of data analysis and machine learning methods. I will discuss the misconceptions in the interpretations of Occam's razor and how can we replace it with this more precise term to form a useful tool in our apparatus to understanding of nature.

10 Aug
9:45am
A2

Criticality in natural systems and human activities

Shahab Bahreini Jangjoo
Shiraz University

What is criticality? Why is it important in many parts systems? Criticality would be exposed in such systems that minor disturbances get replied by catastrophic events. In mathematical point of view, when power-law scaling behavior appeared in a dynamical systems it is known as critical behavior. This behavior is well defined by second-order phase transitions and critical points in statistical physics. But what about natural systems like brain, weather, societies etc.? During the last century a lot of efforts and investigations have been done around the complex systems and a large amount of clues on criticality have been reported in this area; But the missing part in natural mechanisms was lack of external tuning control value. Natural systems are self-organized to criticality which is known as SOCs. On the other hand, so far criticality is the only known general mechanism in complex systems. Inflation in markets, human brain activities and amount of CO_2 releases in an area, etc. follows power-law distribution, which is the significant sign of criticality. This talk would be around the importance of criticality in complex systems and its clues in natural ones especially human brain and human behaviors.

Death and revival of chaos in dynamical systems

10 Aug
10:00am
A2

Bálint Kaszás

Eötvös Loránd University

We investigate the death and revival of chaos under the impact of a monotonous time-dependent forcing that changes its strength with a non-negligible rate. Starting on a chaotic attractor it is found that the complexity of the dynamics remains very pronounced even when the driving amplitude has decayed to rather small values. When after the death of chaos the strength of the forcing is increased again with the same rate of change, chaos is found to revive but with a different history. To characterize these dynamics, the concept of snapshot attractors is used, and the corresponding ensemble approach proves to be superior to a single trajectory description. The details of this chaosnonchaos transition depend on the ratio of the characteristic times of the amplitude change and of the internal dynamics. It is demonstrated that chaos cannot die out as long as underlying transient chaos is present in the parameter space. These observations need to be taken into account when discussing the implications of "climate change scenarios" in any nonlinear dynamical system.

13 Aug
4:15pm
A1

The Entropy of Economics: Calculating Economic Inequality through Statistical Mechanics

Anmol Lamichhane
Earlham College, USA

Have you heard of the 1%? Can we use thermodynamics and statistical mechanics to predict and understand economic or other socio-political inequalities that leads to the creation of the 1% class? I present various statistical mechanics models that could be used to better understand such inequalities.

Computational Physics

Lattice Boltzmann Methods: First Clash

13 Aug
3:00pm
A2

Grzegorz Lukas

University of Wrocław

Lattice Boltzmann methods (LBM) is a type of methods for fluid simulation used in computational physics. LBM uses simple dwo-step algorithm. In first step it calculates collisions while the second step is responsible for calculating propagation of the fluid. Currently theoretical base for LBM is provided by Boltzmann kinetic theory. There is a substential number of methods that belong to LBM type. The most widely used is BGH (named after Bhatnagar, Gross and Krook, the three scientists who introduced it in 1954). Its success is caused by simplic- ity and intuitiveness. A simple application of BGH will be shown, as well as theoretical background and comparison with other methods.

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13 Aug
3:15pm
A2

Numerical Integration in Physics - Parallelization Algorithms with OpenMP and CUDA

Robert Poenaru
University of Bucharest

Numerical integration is one of the most important topics in Numerical Analysis and also a must-have tool for physicists which work on various problems. It consists in finding numerical values for functions which can be very hard or even impossible to integrate in an analytical fashion. There are many methods for integration, each with its typical advantages and disadvantages like complexity, time execution on the machine and so on. Parallelizing these programs can help reducing the amount of time required for computation, and also can help to simplify the algorithm itself. In this work, few methods are presented together with the developed code in C++, OpenMP and CUDA.

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13 Aug
3:30pm
A2

Developing and applying an effective implicit method for discrete dislocation dynamics simulations

Gábor Péterffy
Eötvös Loránd University

Crystalline materials deform plastically due to the movement of linear dislocations in the crystal. The way how these dislocations move or get stuck explains work hardening, size effects, creep and several other technologically important phenomena, hence this is an actively investigated and developed subfield of materials science.

Dislocations exhibit complex spatiotemporal dynamics due to their long-range mutual interactions via their induced stress

fields. The mathematical description of this system leads to stiff differential equations. Solving them with explicit methods on long time scales is computationally rather demanding. Nonetheless, all the currently applied algorithms are based on different explicit methods both in 2 and 3 dimensions. Although implicit methods are generally more suitable for such problems, because of the long-range interactions, the computing cost can be even higher for a large number of simulated dislocations.

We developed a new implicit method, which decreases the simulation run time efficiently in 2 dimensions with reducing the complexity of the mathematical system using physical principles. Our in-depth analysis showed that, while keeping the same numerical precision, the run time decreased with several orders of magnitude. It is expected that it will facilitate simulations of larger specimens in the future.

Machine Learning in the CMS Experiment

13 Aug
3:45pm
A2

Joona Havukainen
University of Helsinki

While the experiments at the Large Hadron Collider are collecting unprecedented amounts of particle collision data, the methods of data analysis become increasingly important. Machine learning algorithms offer a way to perform multivariate analysis in many different problems encountered in experimental high energy physics. The amount of data and sophisticated simulation framework for the particle collision experiments gives an ideal setting for various machine learning approaches. In this talk I will present different examples of the analysis done in the CMS Collaboration where machine learning plays a role. Starting from reconstructing the flight paths of the particles in the detector to selecting events that potentially contain new particles beyond the Standard Model, the use of multivariate analysis techniques that learn directly from the data and simulations offers a way of improving the accuracy and effectiveness of particle physics experiments.

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13 Aug
4:00pm
A2

Improved Model for Electron-surface Interactions in PIC/MCC Simulations of Capacitively Coupled Plasmas

Benedek Horváth

Eötvös Loránd University

Particle-in-Cell/Monte Carlo Collisions (PIC/MCC) simulations provide a self-consistent kinetic description of capacitively coupled plasmas (CCPs), with which the spatio-temporal distributions of various plasma parameters can be observed efficiently. The electron-surface interaction has a remarkable influence on the plasma parameters such as electron density, electron heating and ionization dynamics in CCPs. Despite this, it is still common to describe this process in PIC/MCC simulations in a simplified way by assuming that all electrons are absorbed after hitting the electrode or defining a constant probability for electron reflection.

In this work I implement a realistic model for the electron-surface interaction based on Vaughan's theory and previously applied by Sydorenko. In this model four different processes are taken into account when an electron hits the electrode: elastic reflection, inelastic reflection, true secondary electron emission and absorption. Their probabilities are all energy and angular dependent.

I investigate CCPs in argon between SiO_2 electrodes at low pressure (0.5 Pa). I compare the results of simulations using the improved model with the ones assuming a constant 0.2 elastic reflection coefficient. I also highlight the effect that the variation of the voltage and the ion-induced secondary electron emission has on the discharge characteristics.

Environmental and Atmospheric Physics

LEDs and their efficiency challenge

12 Aug
9:30am
A3

Wiebke Hahn
TU Dortmund

Taking a look at today's electricity consumption lighting accounts for approximately 20% depending on the country's total consumption. To enable significant reduction in electricity production and to gain maximum energy savings, solid-state lighting (SSL) is required to perform at the physical limits of electricity-to-light conversion efficiency. That is one of the reasons why the pioneers Isamu Akasaki, Hiroshi Amano and Shuji Nakamura were jointly rewarded with the 2014 Nobel prize in physics "for the invention of efficient blue light emitting diodes which has enabled bright and energy-saving white light sources". However, nitride LEDs exhibit such high efficiency performances only when operated at low current densities. But to penetrate the market delivering maximum energy savings with lower lamp costs ($\rightarrow$ cost of ownership), LEDs have to work at high carrier injection. Operating at high carrier injection causes a non-linear phenomenon, the so-called droop, which diminishes the internal quantum efficiency (IQE). So far, the fundamental causes of this efficiency droop have not been fully understood since there are several processes such as quantum-confined stark effect, Auger recombination and electron overflow, where it could origin from. Additionally, to those processes Yuh-Renn Wu et al. showed in 2012 that the Indium content inside the quantum well (QW) of LEDs fluctuates, which leads to strong disorder and localisation effects which might also decrease the IQE.

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12 Aug
9:45am
A3

Effect of Geomagnetic Super Substorm at Low Latitude Stations

Binod Bhattarai
Tribhuwan University

Several phenomena like solar energetic particles, geomagnetically induced currents and ionospheric disturbances that can cause frequent radio and radar scintillations, failure of power grids, disruption of navigation by magnetic compass and auroral displays at much lower latitudes than normal in earth are associated with geomagnetic storms. Substorm occur more frequently during a geomagnetic storm and one substorm may follow the previous before its completion. The geomagnetic Northward component (X) field of the four stations in the equatorial and low latitude region were taken to study their variations during super substorm events of April 05 2010, August 24 2005 and November 24 2001. The location of stations extends from Asia to South America across Africa. We studied the storm time (Dst) variations in the Northward component (X) of geomagnetic field at low latitude stations during super substorm events and to substantiate the results, wavelet transform and cross correlation techniques were used. We checked the correlation of Northward component (X) with Dst, SYM-H, Bz, X, Y and Ey individually to show that geomagnetic effect during the super substorm events at low latitude is significant. The power regions with the maximum fluctuation were analyzed using the continuous wavelet transform.

Thermo-graphic image processing on FPGA to test and characterize solar panels/photovoltaic module

12 Aug
10:00am
A3

Issam Bouganssa
Mohammed V University

The importance of operating temperature solar/photovoltaic module for its electrical performance is well known, and the need for fast and reliable *in-situ* monitoring techniques for PV fleet efficiency. Nowadays, these techniques are based notably on "data acquisition" classical measurement principles. These are time consuming and unreliable are when measuring equipment is not suitable and certified. The challenge for in situ reliable, fast and accurate technique to adequately estimate a performance of the PV module is more than obvious. This paper examines the relevant correlation between the operating temperature of an in situ PV module and its electrical performance relative, they characterize by heat treating graphic pictures on FPGAs. The advantages and disadvantages of this technique are discussed in an effort to facilitate the process/maintenance monitoring in applications of solar energy.

Fluid Dynamics

Soft body model for real time droplet simulation

10 Aug
10:15am
A2

Tomasz Bonus
University of Wrocław

Fluid simulations are complicated and computationally intensive, making them difficult to perform in real-time. Using existing soft body model we can get a result which is very close to the lifelike behaviour of single droplets. The main advantage of this method is that we perform simulation in real time, which makes easier to make changes in parameters of simulation without time-consuming calculations. This is achieved by basing the model on simple thermodynamic laws and use of Clausius-Clapeyron equation to calculate pressure forces.

$$PV = nRT$$

Concept of this method is to use the pressure force acting on each face of a closed surface of the model. Combining this approach with existing springmass engine we can simulate the behaviour of single droplets in real time. I will present my implementation of the soft body model and test its basic physical properties. This can be used to quick simulations of the droplet in a porous medium, droplet bouncing on membrane vibrating with variable frequencies or vein and artery problems caused by high-pressure blood flow

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10 Aug
10:30am
A2

CFD simulation to detect the pressure variation caused by the propagation of a ship in shallow water.

Abhishek Gupta

Institute Superior Tecnico, Lisboa

Intrusion detection is a vital problem for the border surveillance especially in shallow water. Underwater sensor networks (UWSNs) are the enabling technology for the intrusion detection. The propagation of a ship creates a disturbance in the surrounding region which causes the pressure variation. This variation is the key to detect the ship. Using the ANSYS Fluent we have designed an intrusion detection system by distinguishing the ship generated pressure fields. Simulation of ship flow in a river has been done with the non-linear shallow water wave equations which yields the potential function with which the pressure is calculated.

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10 Aug
10:45am
A2

The role of compressibility in the velocity shear-induced self-heating mechanism

Giorgi Tsereteli

University of Tbilisi

In the present research we study the influence of compressibility on non-modally induced self-heating mechanism. For this purpose we study the set of equations governing the hydrodynamic system. In particular, we consider the Navier-Stokes equation, the continuity equation and the equation of state, linearize them and analyze in the context of non-modal instabilities. Unlike previous studies in the Navier-Stokes equation we include the contribution of compressibility, thus the bulk

viscosity. By analyzing several typical cases we show that under certain conditions the second viscosity might significantly reduce self-heating efficiency even if the mentioned viscosity is small compared with the normal viscosity of a fluid.

Materials and Solid State Physics

Ab initio study of magnetic and magneto-optical properties of doped CdTe

10 Aug
9:30am
B2

Abderrahim Ait Raiss
Mohammed V University

On the basis of ab-initio calculations, the magnetic properties of CdTe doped with transition metals Mn, Fe and co-doped with both, which make this material a possible candidate for spintronic applications, have been investigated. Moreover, the density of states (DOS) for different dopant concentrations have been calculated and plotted with the energy diagram, we studied the experimental results of the doping of CdTe and determined which one is responsible of the magnetism appearing ,Mn or Fe ,then we observed the effect of the co-doping with Mn and Fe. We found that the iron Fe does not contribute strongly in the magnetism but affect the optical properties of the DMS, so in experimental work we find that a low concentration of Fe improves well the Faraday rotation, which is a magneto-optical property. Furthermore, we have found that the studied system is either ferromagnetic or anti-ferromagnetic, according to the difference in energy between the Disordered Local Moment (DLM) and the Ferromagnetic (FM) states. We also study the electronic structure and the density of states, as to investigate the microscopic behavior of electrons.

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10 Aug
9:45am
B2

Preparation and Analysis of YIG Nanostructures

Maximilian Paleschke

Martin Luther University Halle-Wittenberg

Everyone uses electronic devices to store and modify information, which are operated by an electric current. The general approach of reducing power consumption of these devices capitalizes on reduced feature sizes. But this procedure is reaching its physical limits. One promising solution is the development of spintronic devices which transport information with the electron's spin rather than electron's charge. Many different materials are investigated around the world. The spin damping is one of their key restrictions. If the damping is low enough, a spin wave can propagate over long distances through such a material. An interesting candidate is Yttrium Iron Garnet. The group for nanostructured materials at Martin Luther University Halle-Wittenberg has developed an easy way of depositing YIG onto Gadolinium Gallium Garnet at room temperature using Pulsed Laser Deposition. Heating the samples afterwards yields to highly ordered YIG layers. The aim is now to create free standing bridges of YIG in which a coupling between the magnons and phonons may occur. Foremost, this research requires an understanding of the spin dynamic in small rectangular nanostructures. The talk will focus on the preparation and analysis of such nanostructured samples. Additionally, spin wave simulations via *mumax3* will be discussed.

Moiré Method for Nanometer Instability Investigation of Scanning Hard X-ray Microscopes

10 Aug
10:00am
B2

Jannis Dickmann
TU Darmstadt

The resolution of scanning hard x-ray microscopes is defined by the synchrotron beam brilliance and available x-ray optics, which limit the ability to focus the beam. Today's systems allow a focal diameter of 10 nm and below. To achieve an equivalent resolution of this magnitude, the beam optics must be stable at few-nanometers with respect to the sample. At KTH Royal Institute of Technology in Stockholm, a Moiré method was developed to allow stability measurements. Using simple optical components and visible light, the technique can measure the relative position of two reference points at several centimeter distance and with nanometer precision. The functional principle behind the Moiré method displacement measurement will be presented as well as proof-of-concept stability measurements and applications for 3D nanotomography.

Ultrafast Magnetic Imaging Using High Harmonic Radiation

10 Aug
10:15am
B2

Christina Nolte
University of Göttingen, Germany

Images are an important tool in scientific research and prove in an intuitive way the existence of the object or the physics displayed. We perform magnetic imaging to investigate the magnetic properties of thin films, heterostructures and nanoscale features. In contrast to methods like magnetic force microscopy (MFM) we aim to perform magnetic imaging with nanometer spatial resolution *and* high femtosecond temporal resolution. We demonstrate the first nanoscale magnetic imaging employing high harmonic radiation with circular polarization.

To obtain magnetic information in the recorded image, we exploit X-ray magnetic circular dichroism as a contrast mechanism. The circularly polarized photons transmit through the magnetic sample. The sample modifies the magnitude and the phase of the electric field of the penetrating light depending on the magnetization of the sample and the light helicity. Thus, we are able to image the local out-of plane magnetization of the sample only by transmission of the photons and recording of the far-field diffraction pattern.

For this we need photons with circular polarization in the extreme-ultraviolet (EUV). High harmonic generation is a nonlinear optical process which enables us to generate femtosecond EUV pulses by focusing an ultrashort laser pulse on gas atoms.

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10 Aug
10:30am
B2

Longterm developement of transient networks in an experiment with dipolar hard spheres

Tom Dumont
Universität Bayreuth

Permanent magnetic dipoles may self-assemble to linear chains and rings. This has been investigated for nano-sized particles in ferrofluids; Similar aggregates have also been observed in a mixture of glass beads and magnetized steel spheres, which are shaken in a vessel. In the present contribution I focus on the statistical longterm developement of transient networks in this system, when quenching the amplitude of the vibrations. The observed evolving networks are compared with the computer simulations of the Kantorovich Group, University of Vienna.

The results can be useful in new nano-scale experiments on the condensation of polymer materials.

Dissipative stabilization of a dark soliton in an elongated Bose-Einstein-Condensate

12 Aug
9:30am
B2

René Hamburger
Technische Universität Kaiserslautern

A soliton is a stable solution of a non-linear time dependent wave equation in 1D for example the Gross-Pitaevskii equation (GPE) with the special property to maintain its intrinsic shape and propagating with constant velocity. The GPE provides the time evolution of a Bose Einstein Condensate (BEC) where reduced local particle density is called gray soliton or in case of zero particle density at its center, is called dark soliton with a phase jump of π. In our experiment we work with a BEC of rubidium 87 of which we obtain a real space density image by using the built-in scanning electron microscope (SEM). We try to create a dark soliton with its characteristic phase jump of π, by exposing half of the BEC with a flattop optical potential which we generate using a digital mirror device. Alternatively we make use of the SEM to remove a certain amount of atoms from one half of the BEC since its wavefunctions time evolution depends on its chemical potential. The challenge to address is a solitons instability in 3D due to transverse excitation. Our idea is to stabilize the soliton by local dissipation at its position by utilizing the SEM.

Topological Chern number for Bose-Einstein Condensate

12 Aug
9:45am
B2

Tomasz Szołdra
Jagiellonian University in Krakow

We show how to obtain the topological Chern number of the topologically non-trivial Bose-Einstein Condensate trapped in an optical lattice. Time-of-flight atomic density distribution images after release from trap are used for calculations with Gerchberg-Saxton Phase Retrieval Algorithm. The analysis on simulated data reveals that the method needs only a few measurement points for initial system momenta in the first Brillouin zone, making it convenient for experimental use.

Lowest-Lying Collective Frequencies of a Photon BEC in Presence of Temporally Retarded Interaction

12 Aug
10:00am
B2

Enrico Stein
University of Kaiserslautern

Usually, collective mode frequencies of BECs are theoretically described for an instantaneous two-particle interaction between the bosons. Recent experiments on photon BECs show, however, that the effective photon-photon interaction is significantly influenced by memory effects which are presumably due to diffusion processes. Therefore, we analyse the lowest-lying collective modes of a two-dimensional BEC in presence of a temporally retarded interaction by solving the underlying Gross-Pitaevskii equation with a variational approach. We find that the frequencies for both the breathing and the quadrupole mode are shifted for a few percent with respect to a non-retarded two-particle interaction. Furthermore, we find the

same order of magnitude for the violation of the Kohn theorem, i.e. the dipole-mode frequency differs from the trap frequency. Finally, we discuss how these retardation effects can be enhanced in an anisotropic harmonic confinement. All these findings are essential for determining the photon-photon interaction strength from measuring the lowest-lying collective frequencies of the photon BEC.

Bosonic Systems in Optical Lattices

12 Aug
10:15am
B2

Marko Shuntov
"Ss. Cyril and Methodius" University

This work explores the behavior of many-body bosonic systems in optical lattices. The significance of the optical lattices in the study of many-body quantum theory, their construction and their interaction with atoms are presented, along with some current researches in the field. The Bose-Hubbard model is presented, and the hopping (J) and interaction (U) terms are calculated as a function of the lattice potential depth (V_0) for isotropic and anisotropic square lattices using the quantum harmonic oscillator approximation. The hopping term J is calculated for different sites of the lattice and a comparison between lattices of different dimensions are given. A simple model of two spin zero bosons in two sites is presented. A good qualitative agreement between the presented model and the references is obtained.

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12 Aug
10:30am
B2

Plasmonic excitations in Au induced atomic wires on vicinal Si(hhk)

Zamin Mamiyev

Leibniz Universität Hannover

Metal-induced atomic wires obtained by self-organization on regularly stepped Si surfaces have attracted great interest because of their potential to study exotic quantum phenomena in 1D physics, such as charge density-waves, non-Fermi liquid behavior as well as plasmonic excitations. Depending on the misorientation against high symmetry directions, regular arrays of straight steps and narrow terraces of well-defined width are generated, while the geometry of steps and metal concentration allow the formation of a single or double atomic chain per terrace. The collective electronic behavior undergoes a dramatic change when the geometry is restricted to quasi-1D and electrons in such systems are strongly correlated. Here we illustrate the variability of these systems by a study plasmonic excitations in Au wires on Si(553) and Si(557) surfaces. SPA-LEED was used to control the long-range order of these surfaces. Then plasmonic excitations were investigated via EELS with an instrument that provides both high energy and momentum resolution. During my talk, I will give more insight into effects of every structural building block on plasmon dispersions.

Surface Plasmon Polaritons in Topological Insulators

12 Aug
10:45am
B2

Dewan J. Woods

Purdue University

Surface Plasmon Polaritons (SPPs) are localized electromagnetic wave excitations that travel along a metal-dielectric interface. Excitation of such waves is heavily dependent upon the form of the dielectric permittivity functions of the respective materials. This theory-based talk will be dedicated to an overview of SPPs in different interface configurations and the associated boundary conditions. Discussions will also include how the properties of SPPs change when we consider the interface of Dirac materials, topological insulators (Tis) in particular. A TI is a quantum material that behaves as an insulator in its interior, but possesses conducting surface states – thus the electrons are confined to move only along the surface. SPP propagation in this exotic material has great promise for potential applications in quantum plasmonics devices and it is expected to give great insight into the field of topology as it relates to the growing field of photonics

13 Aug
9:30am
B2

Two and a Half Quasicrystal – the search for an oxidic thin-film quasicrystal from $SrTiO_3$ on Pd(111)

Bettina Leibundgut

Martin-Luther Universität Halle

Ultra-thin perovskite films exhibit extraordinary complex structures on Pt(111) in the two-dimensional limit. Upon reduction by UHV annealing, two-dimensional oxide quasicrystal or closely related periodic approximant structures have been reported for $BaTiO_3$ and $SrTiO_3$ on Pt(111). Here we report on the formation of similarly complex structures from $SrTiO_3$ on Pd(111). The films are grown by reactive molecular beam epitaxy from a Nb-doped $SrTiO_3$ single crystal and a Ti rod. In the evaporation process we have noticed the necessity of a TiO_2 precursor. We have characterised this structure and compared it to the well-known TiO_2 structures on Pt(111). When approaching stoichiometric $SrTiO_3$ films, several large unit cell superstructures are observed, that will be discussed with respect to aperiodic structures.

Investigation of 2-dimensional electron gases, a possibility of generating conduction in insulators

13 Aug
9:45am
B2

Jacqueline Marie Börgers

Peter Grünberg Institute, Forschungszentrum Jülich GmbH, Jülich, Germany

By the formation of a 2-dimensional electron gas (2DEG) at the interface of two electrically insulating oxide thin-films a 2-dimensional conducting channel is created. This can be used for e.g. for transistor components.
I investigate the interface between $LaAlO_3$ and $SrTi0_3$. The reason for the formation of the 2DEG is different if the layers are crystalline or amorphous. In both cases $LaAlO_3$ is deposited on $SrTiO_3$ by pulsed laser deposition (PLD). Crystalline films are deposited while using high temperature (700°C), which makes it possible to grow atomic layer by layer, which can even be observed in real time by electron diffraction (RHEED).
In case of crystalline films the formation of the 2DEG is a consequence of electrical reconstruction at the interface. Apart from that, in the amorphous case, the formation is based on lattice defects in the $SrTiO_3$, which can be created by oxygen vacancy defects.
The aim of my master thesis is to understand the depth profile of this lattice defects in the amorphous case. Various experimental techniques are used for example Hall-measurements to analyse the electrical properties (even at 2K) or AFM and XRD for the crystal structure.

13 Aug
10:00am
B2

2D materials in sustainable technology

Veera Juntunen

University of Oulu

We are living in the turning point of technology. First two-dimensional material was found in 2004, and since then this research field has grown enormously. Two-dimensional materials are one atom thick layers which can be easily removed from layered materials. Layered materials are classified by extended crystalline planar structures held together by in-plane covalent bonds and out-of-plane van der Waals forces.

Material's properties change as their size approaches nanoscale. Thus, many of known 2D materials have interesting properties. Now we are able to build new types of quantum heterostructures by stacking dissimilar 2D layers. We can choose those properties what we want to have and adjusting the angle between two atomic lattices can result in structures with different properties.

2D materials span the full range of electronic properties and we have the possibility to build various electronic devices with high performance and low power consumption. Theoretical analysis has shown that the skin effect is diminished in multilayered graphene, and semiconducting TMDs have many desirable properties for low-power devices.

On the 3D Topological Insulator: Bi2Te3 thin films

13 Aug
10:15am
B2

Sofia F. Teixeira

University of Porto

Topological insulators (TI) appeared as a new type of materials, characterized by an insulating bulk with a protected metallic state on their surface. 3D topological insulators have recently been the focus of researchers due to their exotic theoretical interest and possible applications. One of the recently discovered 3D TI was Bi2Te3, which has a single Dirac cone on its surface. To study the TI properties of Bi2Te3, the fabrication of epitaxial and impurity free thin films is essential. The transport properties of TI are also of great interest, due to the difficulty in observing the protected metallic state in normal measurements. In this presentation, an overview of the multifunctional properties of Bi2Te3 will be presented, with focus on the recent development and study of its TI properties. The fabrication of Bi2Te3 thin films is going to be discussed and how to measure its TI properties through transport measurements is being presented. Finally, preliminary results of transport properties of Bi2Te3 thin films will be presented.

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13 Aug
10:30am
B2

RF Sputtering and PECVD - a comparison

Octavian-Gabriel Simionescu
University of Bucharest

Thin film deposition techniques have evolved greatly in the last century and their diversity grew exponentially. Each deposition technique has its own advantages and disadvantages. They are divided into two large categories. There is Chemical Vapor Deposition (CVD) and Physical Vapor Deposition (PVD). For CVD we have a wide array of techniques: atomic layer deposition/atomic layer epitaxy (ALD/ALE), chemical beam epitaxy (CBE), metal-organic chemical vapor deposition (MOCVD), metal- organic vapor phase epitaxy (MOVPE) and plasma enhanced chemical vapor deposition (PECVD). For the PVD we have: Cathodic Arc Deposition, Electron beam physical vapor deposition, Evaporative deposition, Pulsed laser deposition, Sputter deposition and Sublimation sandwich method, the most common used being Thermal Evaporation and Sputtering. We will concentrate our attention on RF Magnetron Sputtering and PECVD, which are fundamentally a PVD process and, respectively, a CVD process. The main deposited film that we focus on is SiO2 on a Si wafer. Regardless that we are talking about deposition time, film uniformity, deposition temperature and so on, both deposition techniques have their strengths and weaknesses, and they are presented as found, either observed during the process or after it through a characterization method.

Determination of the atom-surface interaction Potential for a Topological Insulator: ^{3}He-Bi_2Te_3(111)

13 Aug
10:45am
B2

Michael Pusterhofer

Graz University of Technology

Materials with peculiar electronic surface effects such as the novel group of topological insulators pose an especially interesting topic for truly surface sensitive measurement methods such as helium atom scattering (HAS). Since the diffractive interaction of low-energy atoms with surfaces depends on a multitude of parameters, the total interaction profile between the helium atom and the surface under investigation must be known with a high degree of certainty. Although several atom scattering experiments have been performed on topological surfaces, surface preparation of complicated layered materials is difficult at best and angular scattering spectra are therefore often too noisy to gather important surface parameters. Recent ^{3}He diffraction experiments from in-situ cleaved single crystals of Bi_2Te (111) revealed a multitude of distinct resonance features in between the diffraction peak maxima. Using the angular positions of these features and an extended analysis over several measurement cycles, we were able to identify ten distinct bound-state energies of the ^{3}He-Bi_2Te_3 (111) interaction potential. Using these eigenvalues as the source for a potential fit, a full three-dimensional interaction profile can be fitted to an azimuthal scan via an extended close-coupling (CC) calculation. Modelling the scattering intensities via an elastic CC calculation provides a quantum mechanically accurate way of testing a provided interaction profile against measured intensity data. With our fitting procedure we obtain an accurate three-dimensional ^{3}He-Bi_2Te_3 (111) interaction profile which will pave the way for a better understanding of topological insulator surfaces.

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13 Aug
3:00pm
B2

Simulation of high energy XPD-patterns for structure determination of surface and interlayer structures of solids

Robert Rauter
TU, Dortmund

Photoelectron diffraction (XPD) is a powerful tool to examine surface and interlayer structures of solids. In order to extract the structural information from the experimental data, simulated XPD patterns are compared to experimental XPD patterns. For determining the correct structure a multiplicity of different surface and interface layer structures must be considered within the simulation. Reducing the quantity of simulations is achieved by utilizing a genetic algorithm.

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13 Aug
3:15pm
B2

Nonlinear acoustic wave generation due to thermoelectric effect in organic conductors

Biljana Mitreska
Ss. cyril and methodius university

We investigate the nonlinear electromagnetic-acoustic transformation (EMAT) in a quasi-two-dimensional organic conductors arising from the thermoelectric effect. Magnetic field and angular dependencies of the generated acoustic wave are obtained under the condition of a normal skin effect when a source of thermoelastic stresses is the time dependent Joule heating. When an electromagnetic wave of frequency ω is incident on the surface of the conductor, whose symmetry axis does not coincide with the normal to the surface, nonuniform temperature oscillations appear due to the thermoelectric effect which induce acoustic oscillations with double frequency 2ω in the conductor. A comparison with the inductive mechanism of EMAT is made in order to determine the conditions at which the thermoelectric mechanism is dominant over the inductive one in the presence of a magnetic field. This will allow new important information on the electronic structure of the organic layered conductors to be obtained.

Magnetic Field as a Tool to Control Transmission and Polarization Transformation in Layered Superconductors

13 Aug
3:30pm
B2

Tetiana Rokhmanova

O.Ya. Usikov Institute for Radiophysics and Electronics

Layered superconductors represent periodic materials, in which thin superconducting layers are separated by the thicker insulator ones and are electrodynamically related to each other by means of intrinsic Josephson effect. Such structures support propagation of waves of terahertz frequency range, which makes them interesting for terahertz electronics. On the other hand, studying the interaction of strong terahertz pulses with layered superconductors may reveal new possibilities for high-temperature superconductive state control. The talk presents both general information about layered superconductors family and a specific problem solved for such structures. In the problem, the effect of the external static magnetic field on the electromagnetic waves transmission and transformation in layered superconductors is studied. It is shown that even weak magnetic field can change significantly the conditions for the waves propagation in layered superconductors. Because of this, changing the DC magnetic field, one can vary the transparency of the sample in a wide range or switch the sample from the state with partial polarization transformation to the state with total polarization transformation, and vice versa.

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13 Aug
3:45pm
B2

Retroreflection from a Superconductor

Viktor Könye

Eötvös Loránd University

At an interface between a superconductor and a normal metal the so called Andreev retroreflection can occur. This is a charge transport process where two normal electrons are transferred to the superconductor as a Cooper pair. After the charge transfer a hole is retroreflected from the interface. The talk will outline the theoretical aspects of understanding the phenomena in the framework of the Bogoliubov-de Gennes model. After that numerical results will be shown calculated using the kernel polynomial method.

Ultrafast Lasers & Femtochemistry or: How we can make "Movies" of Molecules in Motion

13 Aug
4:00pm
A3

Sascha Ranftl

University of Technology, Graz

In 1999 Ahmed Zewail won the Nobel Prize for the very first direct observation of a molecules' dissociation using laser pulses of a few hundred femtoseconds. In this talk I will give a short introduction into ultrafast lasers: how a so-called FROG uses autocorrelation and the diffraction of the laser with itself to take a "picture" of the pulse, why we need a sophisticated experimental setup to access sub-picosecond time scales and how we can use it to directly observe quantum particle dynamics, i.e. shooting a "movie", demonstrated with an example on dissociation dynamics in acetone.

Betatron Radiation from Cryogenic Clustertargets

13 Aug
4:15pm
A3

Andre Sobotta

Heinrich Heine Universität, Cologne

Batatron radiation can be produced in tabletop experiments from wakefields in Laser Plasma interaction, which in future can be a affordable alternative to big accelerator facilities, making hard X-rays acessible at university laboratories. Masslimited Targetmaterials such as nanometer sized cryogenic Clusters can be used to increase conversion efficency. Simulations and an experimental setup for from my current PhD work will be presented.

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13 Aug
9:30am
B1

Modelling optical line shapes with multidimensional Taylor Series

Nikodem Stolarczyk

Nicolaus Copernicus University

One of the most important branch of molecular spectroscopy is modelling of spectral line shapes. Not only it is useful for science itself, like testing if the theoretical descriptions of the way the molecules interact are correct or creating spectroscopic databases , but also can be applied to analyse human breathing, atmospheric measurements of the distant planets or ultra-accurate meteorology, e.g., exact determination of the Boltzmann constant. The more exact results are demanded, the more accurate models need to be implemented. In general, the molecular collisions should be taken into account which makes the line shapes enormously complex. It is describable by the transport-relaxation equation, nevertheless, it is extremely complicated to solve it exactly because of multidimensional integrals, making numerical attempts either time demanding or not accurate enough. The goal of the talk is demonstrating another way of solving the transport-relaxation equation. In opposite to brute-force methods, the new way to tackle this problem is to calculate the value of function and its derivatives only once and expand this into a global solution using Taylor series. Despite having some drawbacks, the method is very efficient and has a potential for a wide implementation in future research.

Modeling Conductive Domain Walls by means of Random Resistor Networks

13 Aug
9:45am
B1

Benjamin Wolba
TU Dresden

A random resistor network is an electrical network of ohmic resistors, for which the electrical resistivity of a single resistor is randomly determined according to a certain resistance distribution. They are not only intrinsically interesting from the electrotechnical point of view. Moreover they are also quite useful for modeling electronic transport in systems with phase separation, like in composite media or in manganites undergoing an insulator-metal-transition, as well as in lower dimensional systems such as graphene or even DNA-strings. Here the random resistor network approach has been employed to model the conductivity of domain walls in uniaxial ferroelectrics, such as lithium niobate $LiNbO_3$. Recently the inclination angle distribution of a domain wall in lithium niobate has been measured locally by Godau et al., using a Cerenkov second-harmonic generation method for 3-dimensional domain wall mapping. This data has been used as experimental input for a random resistor network model - addressing the electronic transport along the domain wall for different boundary conditions. The simulation results are directly compared to local-scale transport measurements conducted by means of conductive atomic force microscopy

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13 Aug
10:00am
B1

In-Plane Electronic Speckle Interferometry And Usage in Shearography

Adrián Costa Boquete
University of Santiago de Compostela

This project is focused on certain shearing interferometry techniques, derived from speckle interferometry. First, the speckle phenomenon and some of its most important characteristics will be introduced. The next point will be the further examination in speckle interferometry and its application in the direct measure of displacement derivatives (shearography). Then the experiment performed, in which a shearing interferometer is implemented, will be explained. The ease to pick the direction in which the strains in a tense flexible membrane can be measured will be shown. Last, the size of the speckle grain will be calculated using results extracted from the experiment.

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13 Aug
10:15am
B1

Microstructure and mechanical properties of ultrafine-grained aluminum consolidated by high-pressure torsion

Péter Nagy
ELTE

Coarse-grained aluminum powder with 99.95 wt.% purity was consolidated by high-pressure torsion (HPT) technique at room temperature using a low carbon steel powder holder. In this process, the powder experiences a semi-constrained condition because the internal wall of powder holder can expand under the load applied during HPT. After 4 turns of HPT a relative density of 99.83% was achieved. The microstructure was characterized by electron backscatter diffraction and X-ray line

profile analysis. It was found that the grain size decreased while the dislocation density increased with both increasing the distance from the disk center and the number of HPT turns. The smallest grain size and the maximum dislocation density with the values of $0.41\mu m$ and $6.8 \times 1014m^{-2}$, respectively, were achieved at the periphery of the disks processed for 4 turns. Tensile tests showed that consolidation of Al powder by 4 turns of HPT yielded a high ultimate tensile strength and a good ductility ($\sim$ 373 MPa and $\sim$ 22%, respectively). It turned out that dislocations are the main reasons of the high yield strength in the present Al samples. This study demonstrates the capability of HPT technique for processing consolidated Al powder with high strength and good ductility.

Designing Mechanical Metamaterials

13 Aug
10:30am
B1

Freek Broeren
Delft University of Technology

Recently, there has been an increasing interest into materials with mechanical properties that can be tailored no by changing the chemical composition, but by applying a microstructure. In this way, material properties can be achieved that are not found in nature, such as negative Poisson's ratios, vanishing shearand bulk moduli or highly anisotropic elastic moduli. A great number of these materials have been investigated and published, but up to now, the design of these structures seems to rely mostly on intuition. In this talk, I will present an approach to designing mechanical metamaterials using pseudo-rigid body (PRB) models. These models allow the designer to design the kinematics of the materials without having to consider all the elastic properties of their constitutive materials. This leads to an analytically solvable system that can be iterated quickly, without the need for finite element simulations. By adding torsional springs to these models, even the stiffness of the eventual material can be modeled and tuned to the required behavior. By using PRB models to design mechanical metamaterials, the designer can use the well-established toolbox used in the design of linkages, enabling a more rational design approach.

Nuclear Physics

Products of exotic nuclei decay

13 Aug
10:45am
B1

Joanna Peszka
Wrocław University of Science and Technology

Interesting issue in the field of nuclear physics of low-energy is study of exotic decays. Exotic nuclei are the artificially produced isotopes, which lie near the border of stability and because of the considerable disparity between the number of protons and neutrons in the nucleus they decay by $\beta+$ channel. Created nucleus could be in excited state and after proceed to a lower energy state by emission of a proton. Such a reaction is called β-delayed proton emission. Usually the reactions are found by detection of γ quanta, but in the case of decay of exotic nuclei, where radiation is not emitted, a different technique must to be used. The detection of delayed proton system is called OTPC (Optical Time Projection Chamber), it is a drift detector with an optical readout. During the speech mechanism of β-delayed proton emission and the construction and operating principle of the detector OTPC will be discussed.

Other Interesting Topics

The story of Newton's laws

10 Aug
9:30am
A1

Raimundo Sieso Ortiz

UNED

Galileo and Newton were the parents of modern science but it is said that both stood on the shoulders of giants. So, who were those giants? From Aristotle to Newton, there is a fascinating voyage though the sea of Physics and Philosophy. Aristotle began with his Looney Tunes-like world and the medieval scholars used this as a starting point to develop their ideas. We will learn about William of Ockham and his forma *fluens* and about Buridan and his *flux formae*. Furthermore, the latter invented the idea of *impetus*, a very similar concept to the modern linear momentum! We will finish with the Merton calculators and with Oresme, who developed a system to draw qualities, the ancestor of the cartesian axes

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10 Aug
9:45am
A1

The Medieval Trebuchet

Yannick Linke

Dasy

The trebuchet is a battle machine used in the Dark Ages to launch heavy payloads at enemies. It was preferred over a catapult due to larger range and higher accuracy. However, due to its many components, the physical description is surprisingly rich and complex.

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10 Aug
10:00am
A1

It is two and a half minutes to midnight

Cecilia Meneses-Ponce

Universidad Autónoma Metropolitana (Campus Iztapalapa), Mexico.

Throughout the history of humanity, physics has given us the greatest discoveries, creations and hopes for a better world. However, the development of physics also gave us a few years ago (after World War II) one of the most important life lessons for humanity, and it was the understanding of the fragility of life on our planet. When scientists responsible for the creation of atomic bomb noticed the destructive potential of nuclear weapons and their consequences, many of them came together to demonstrate against their use, so they created the Bulletin of the Atomic Scientists in whose front page the famous Doomsday clock first appeared, with the passage of time has changed the place of the hands with respect to the position of the midnight, reminding us how close we could be to terminate with "everything". Other parameters like climate change, biosecurity, nuclear energy and others are also currently considered to advance or delay the time of the clock. So if the development of science was part of all this, it is also part of the solution and of course physics represent a wonderful opportunity to improve our world.

Calculating the simple pendulum's period with the given amplitude using the Gauss' hypergeometric function

10 Aug
10:15am
A1

Šarolta Cako, Olivera Vujinović

University of Novi Sad

It is well-known that in many structures in nature, a system settles at a minimum of energy and undergoes oscillations or vibrations about it. Pendulum is seemingly a very humble and simple device. It represents a great example of rotational motion of a mass hanging from a fix point by a taught massless string of certain length. In the equation of motion of this system it is usually assumed that $\sin\theta$ is small enough to make the substitution $\sin\theta = \theta$. This means that the width of the pendulum's swing – amplitude must be very small. But, what if our pendulum wants to experience some freedom and excitement? Since we do not want to cut the string, the only thing that can be done in order to accomplish this is to let the pendulum have bigger amplitude. Consequently, the aforementioned approximation cannot be used. Luckily, Gauss' hypergeometric function is there to save the day!

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10 Aug
10:30am
A1

Diamagnetism and Levitation

Bellona Bles
University of Novi Sad

Throughout time people have always been intrigued whit every form of flying and still are trying to bring it to reality, in different forms. Thus as the ultimate form of flying levitation was indeed mysterious and as a phenomenon it can be explained and put in applications today. In my 12 minuets I would like to explain the physics behind real levitation witch comes form the diamagnetic property of the material and why we call this form of levitation a "real levitation" as well.

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10 Aug
10:45am
A1

The Centripetal and Centrifugal Forces

Bishal Banjara
Tribhuwan University

It has been long time (nearly three centuries), when Isaac Newton had first derived the only and only existence of centripetal acceleration/force in circular motion within the uniform magnitude of tangential velocity, in his book "Principia". This brought a controversial issue in different experiments and rejected to use the term "centrifugal" acceleration/force in such circular motion, presuming that all that sort of force is only the fictitious, not real force discarding our daily life experiences. But due to lack of proper mathematical framing, such physical experiences remained just as a fictitious or a pseudo experience. This paper is all about the validation of $\omega^2 r$ (V^2/r) as a real mathematical as well the physical form that corresponds to both radial centripetal acceleration, $\omega^2 r\tilde{r}$ and real tangential acceleration, $\omega^2 r\tilde{\theta}$ (a simple step derivation, but a scientific breakthrough) in circular motion within the uniform

magnitude of tangential velocity, verifying the real existence of centrifugal acceleration/force but varying in both magnitude and direction scale.

From undergraduate student to PostDoc researcher; A(n) (un)typical evolution and development in science

13 Aug
3:00pm
A1

Dominik Utz

Karl-Franzens University

After uncountable many ICPS participations it might have come the time to give some review about the personal and scientific evolution over a period of more than 10 years. Thus we will have a look not only into the science of the solar magnetism, and here especially on small-scale features known as magnetic bright points (MBPs), but also mix this interesting scientific research with some annecdotes of personal development, travelling, fun, and hopefully some hints of how to make a living in science and research.

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13 Aug
3:15pm
A1

The Vulcanus in Japan Programme

Monika Schied
University of Graz

In the framework of Vulcanus in Japan (ブルカヌス・イン・ジャパン), a scholarship programme for European students of engineering and science, I have been living in Japan for one year, learning the language and working at NTT Basic Research Laboratories.

Of course, moving abroad is a big challenge and therefore inconvenient; the prospect of having to learn a language like Japanese even frightening (it is easier than you expect). Exchanging your familiar surroundings with a country where you cannot even read the labels in the supermarket needs a huge amount of courage.

However, the EU-Japan Centre for Industrial Cooperation organising the Vulcanus programme offers reliable support in all important aspects of your life in Japan. Furthermore, since there are tens of other participants with the same schedule, the same problems, and the same questions, you are not alone. Therefore, the adventure loses its threat and you can fully enjoy your new life.

Studying the language, working in a company and exploring the country in the spare time provides a unique insight into the rich Japanese culture. Looking back, I can highly recommend a stay abroad. Keep in mind:

井の中の蛙大海を知らず – A frog in a well does not know the great sea.

Particle Physics

Designing a particle accelerator - conditioning of copper electrodes high-voltage dc pulses

10 Aug
10:45am
B2

Anton Saressalo
University of Helsinki

The lifetime and new discoveries of the Large Hadron Collider in CERN will come to an end during the 2020's, and its replacements are already being designed. One of the main competitors is a Compact LInear Collider, CLIC - an over-50-km-long linear structure accelerating electrons to high energies. As CLIC uses large radio-frequency electric fields of over 300 MV/m to accelerate the electrons, the accelerating structures need to be able to sustain high stresses. Finding the right materials for this task has been challenging. Currently, copper is the most promising material, but electrical breakdowns between copper blocks have been causing problems. This work aims to understand the atomic scale phenomena behind the breakdowns, and to find the correct conditioning and treatment methods to minimize their amount. Discrete Dislocation Dynamics simulations are run in parallel with experimental DC pulsing measurements to allow connection of the microscopic phenomena to the macroscopic observations.

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12 Aug
9:30am
A2

The problem of vacuum metastability within the Standard Model

Goran Jelic-Cizmek
University of Geneva

With the recent discovery of the Higgs boson at the LHC, the Standard Model of particle physics has been completed. Assuming that no new physics emerges between the electroweak scale ($\sim$ 100 GeV) and the Planck scale ($\sim$ 1019 GeV), it has been shown that the Standard Model effective potential exhibits an instability at energy scales higher than $\sim$ 1011 GeV due to renormalization group flow of the Higgs quartic coupling λ. This seems to indicate that our current vacuum state could be a false vacuum, separated by an energy barrier from a true vacuum. Owing to quantum tunneling however, the current state could only be metastable, and may in fact one day decay to the true vacuum. While the idea of false-vacuum tunneling has been explored in the past, with the absence of any new physics at current high-energy experiments, it has been gaining new attention in the recent years. It has been suggested that certain high-energy phenomena in the early universe, such as inflation and primordial black holes, could trigger the decay. In this talk, I will briefly go over the effective potential calculation for the Standard model to show how the instability arises in the large-field regime, and describe its main features, followed by an overview of the semiclassical theory behind vacuum decay in flat as well as curved spacetime. Finally, I will present the numerical results obtained for the decay rate in a curved background for some simple geometries, with and without a non-minimal coupling of the Higgs field to gravity.

Supersymmetric Beasts and Where to Find Them

12 Aug
9:45am
A2

Baptiste Ravina
University of Sheffield

In this (hopefully) accessible talk, I'll give insights as to how we do experimental particle physics, by looking at the example of the search for the supersymmetric partner to the top quark in hadronic final states at the ATLAS experiment. But what is supersymmetry? How does a detector work? How do we look for things we cannot see? What are the latest news from Run 2 of the LHC? – these are the questions I'll try to answer, and more.

The Large next-to-leading order Electroweak Correction to $e^+e^- \to t\bar{t}$

12 Aug
10:00am
A2

Bianka Meçaj
University of Paris-Saclay

In this work we address the subject of large next-to-leading order (NLO) electroweak correction to the process $e^+e^- \to t\bar{t}$. We try to understand the origin of this large contribution by using the GRACE-loop software to perform the NLO calculations. Our technique of approaching the problem consists in analyzing the differential cross section angular distributions for different initial and final state polarizations and in addition investigating contributions from different Feynman diagrams. In the first task we extract the cosine dependence of the angular distributions when NLO corrections are included and compare them with the tree-level angular distributions. Secondly we separate the diagrams in a gauge-invariant way and seek to understand from which group of diagrams the large correction comes from. A particular attention is given to the box diagram when the W boson is in the loop. Our work is of special interest for the future International Linear Collider (ILC) where polarized initial states will be accessible and the process e $e^+e^- \to t\bar{t}$ can be studied in details to confront the findings of our work.

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12 Aug
10:15am
A2

Anisotropic flow in heavy ion collisions

Alexandra Neagu

University of Bucharest

Heavy ion collisions at relativistic energies are an experimental method to study the structure of the matter and its behavior under extreme conditions of temperature and density. Nowadays, one of the main goals of nucleus-nucleus collisions at high energies is to study the quark gluon plasma in which the quarks and gluons are no longer confined. One observable which is used to characterize the properties and the evolution of this new created medium is the anisotropic flow. In this work I present the measurements of different coefficients of the anisotropic flow for inclusive particles in nucleus-nucleus collisions using simulated data.

Scintillating Bolometer Monte Carlo for Rare Particle Event Searches

12 Aug
10:30am
A2

Nicholas Deporzio
Northeastern University

This study uses the Geant4 physics simulation toolkit to characterize various scintillating bolometer constructions for potential experimental commissioning. Emphasis is placed on detector sensitivity to neutrinoless double-beta decay. Constructions minimally include a scintillating source material for the decay and an absorber material. Tellurium, Selenium, Germanium and other candidate isotopes are studied as source materials. Various background discrimination techniques are analyzed including reflective housings and anti-reflective coatings upon the source material. Different geometric optimizations are considered. Ability to discriminate incident alpha and beta radiation, as well as photon detection efficiency for each construction is presented.

Coulomb-dissociation at Samurai detector

12 Aug
10:45am
A2

David Hegedus
Eötvös Loránd Tudományegyetem

In my presentation I present the first part of the evaluation of an experiment of the Samurai detector system of the RIKEN about the Coulomb-dissociation of 15C. The Coulomb-dissociation is a much studied electromagnetic interaction which has a significant role the research of astrophysical processis and in the structure of exotic nuclies. I detail what preparations are needed from the detailed understanding of the detector system to the final physical datas that can be used in the evaluation.

The main goal was precise analysis of the relative momentum vector between the fragment and the emitted neutron.

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13 Aug
9:30am
A2

Search for Z' in the dimuon channel with the CMS experiment

Saverio Mariani

Università degli studi di firenze

Nowadays, describing the fundamental fermions constituing matter and the bosons carrying forces, the Standard Model (MS) is the most complete theory of our knowledge. Nevertheless, some theoretical evidences and sperimental results convince us it is not complete and an extension is required. Among the models proposed, some introduce vectorial bosons' copies at the TeV mass scale called Z' and W'. Previous searches during the LHC Run 1 in the dimuon $Z' \to \mu^+\mu^-$ and dielectron $Z' \to e^+e^-$ channels gave some exclusion limits to the process' cross section. Now, with the improvement of the collisions' energy from 7-8 TeV to 13 Tev, more mass' intervals can be studied, even if the integrated luminosity is low. The following work presents a search for Z' using data collected by the CMS experiment during 2015 for a total integrated luminosity of $\mathcal{L}_{int} = 2.67 fb^{-1}$. The pp collisions correspond to a $\sqrt{s} = 13$ TeV energy in the centre of mass system. Then, two models are used to data's interpretation: the narrow width approximation, where the Z''s width is thought negligible, and the full width approximation, where it is linear with its mass. In the second case, some Z' particles are produced off shell, i.e. with different masses from the expected. So, considering the dimuon channel, in this thesis I chose events with the dimuon mark (respecting some request on isolation and transverse impulse) and reconstruct the invariant mass, so that the signal is distinguishable from background. Then data are compared with MonteCarlo simulations for the signal at different Z' masses and exclusion limits are calculated. In particular, the signal is obtained from a smearing procedure according to the CMS' efficiency and resolution curves. The events' counting indeed is done in a 2σ interval, being σ the experimental resolution, centered on the mass points. Finally, using Poissonian statistics, the definitive exclusion limits are obtained. At 95% confidence level, Z' is excluded for masses lower than 3023 GeV.

Study of the CMS Phase 1 Pixel Pilot Blade Reconstruction

13 Aug
9:45am
A2

Tamas Almos Vami
Eötvös Loránd University

The Compact Muon Solenoid (CMS) detector is one of two general-purpose detectors that reconstruct the products of high energy particle interactions at the CERN LHC. The silicon pixel detector is the innermost component of the CMS tracking system. The Phase 1 Pixel Upgrade is in preparation for installation after the LHC Run in 2016. During Long Shutdown 1 a third disk was inserted into the present forward pixel detector with eight pilot blades constructed using the new digital Read-Out Chip and a prototype readout system. Testing the performance of these pilot modules enables us to gain experience with the CMS Pixel Phase 1 Upgrade modules. In this essay the simulation and the data reconstruction of these new modules is presented.

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13 Aug
10:00am
A2

Search for fully reconstructed decays of the W boson

Timo Eckstein

Friedrich-Alexander-Universität Erlangen-Nürnberg

Currently only the leptonic decay channel of the W boson is used for its mass reconstruction. This is mainly the case due to the comparable clear discrimination criteria as well as branching fraction of $\approx 30\%$. In this work we look into pure-hadronic electronically charged low-multiplicity W boson decays. We found in the conducted simulation that they are as rare as 1 pb and only applicable via the usage of many channels. Thus we determine that they won't become stochastically relevant for the LHCb data before the end of 2018 when the stochastical error will be 15 MeV. Despite this, the aforementioned very specific decay class might nevertheless be interesting in the future because of its full re-constructibility while the HL-LHC upgrade can make them statistically better accessible.

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13 Aug
10:15am
A2

Navigating the Hidden Sector: Designing the SHiP Experiment at CERN

Oliver Lantwin

Blackett Laboratory, Imperial College of Science, Technology & Medicine, London

Particle physics is stuck at an impasse: We have found nothing but the Higgs, and Supersymmetry (SUSY) is nowhere to be found. But the neutrino masses, dark matter and the fact matter overcame anti-matter to create the universe, prove that there has to be new fundamental physics, and that there have to be new particles, somewhere. But they have not been found at the Large Hadron Collider (LHC), nor has anything been

seen by direct detection experiments for dark matter nor by precision tests of the standard model (SM). And without an energy scale to target the justification for any new collider is weak. So where else can we look? The Search for Hidden Particle (SHiP), is a proposed experiment to study a wide range of models invisible to our current experiments. To test these models with super-weakly interacting particles we need to solve an experimental contradiction: We need to achieve an extremely low background environment, while working at extremely high intensities. How we can overcome this experimental challenge and is the main topic of this talk

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Detector Fabrication for the Dark Matter in CCDs (DAMIC) Experiment

13 Aug
10:30am
A2

Ariel Matalon
University of Chicago

There is clear evidence for non-baryonic dark matter, which comprises about 25% of the energy density of the universe. One of the major candidates for dark matter is the WIMP, or Weakly Interacting Massive Particle, which is yet to be detected. Dark Matter in CCDs (DAMIC) is an experiment designed to directly detect WIMPs by utilizing the bulk silicon of scientific-grade charge-coupled devices (CCDs) as target mass for coherent elastic scattering. The current phase of the experiment consists of 675 μm-thick CCDs developed at LBNL based on a design for the Dark Energy Survey Camera. The detectors have a low energy threshold and ability for particle identification, as well as 3D position reconstruction of events due to lateral spread of charge diffusion. The next phase of the experiment will require increased target mass to scale up the overall exposure of the detector and carve out additional parameter space of WIMP cross section in the low mass range. One of my primary efforts is to design and fabricate CCDs of record-thickness at the Pritzker Nanofabrication Facility at the University of Chicago. I will present initial results from the ongoing efforts to develop such devices.

Physics Education

Activities of FYKOS for High School Students and its Educational Benefits for Participants

13 Aug
3:30pm
A1

Karel Kolář
Charles University

This contribution shows a wide range of activities for high school students organized by FIKOS. It describes its goals and achievements and benefits of its activities for participants with special emphasis on the core FYKOS activities (correspondence competition and camps). FYKOS is the only Czech member of IAPS. Organizers (= members) of FYKOS are university students. Participants are mostly high school students, sometimes even younger gifted pupils. FYKOS can be translated as Physics Correspondence Competition. This is the first and core activity of our group which has been organized for 30 years now. The correspondence competition consists of six series of eight problems each school year. Organizers release problems assignments (in Czech and in English) on the web pages of FYKOS. Participants have time to solve these tasks. Participants send solutions by online upload or by post. Organizers correct solutions, send them back to participants and release the list with awarded points to participants. The best participants are invited to camps. Camps are held twice a year for a week. Such week consists of rich expert program concerning physics, mathematics and related topics. Camps are also full of informal program many different games for development of different key competences.

13 Aug
3:45pm
A1

Usage of digital technology instruments at educational laboratories

Maria Katsiampa

University of Crete

This talk presents a research on digital and analog educational laboratory instruments, and their importance to university students and researchers. Based on their technological properties, there are two types of instruments that can find application in an educational electricity laboratory, analog and digital. When analysing analog and digital technology, we refer to the signals that each type of instrument uses. To compare these two types of instruments we measured the voltage of an RLC circuit using an electric oscilloscope of both technologies. In this experiment the importance of high quality digital laboratory instruments is obvious, as analog instruments fail to reproduce the laws of physics accurately. It is important for students and researchers to be able to understand the way their experiment works and process their data at any time. Beyond university laboratories it is even more important for research centres to have measurement instruments with high accuracy, low energy drawing and big data processing possibility, as these instruments are in charge of producing measurements that can lead to new discoveries and verification of laws of physics, making micro electronics field popular and a key factor for new, innovative laboratory technologies.

Holograms teach you Physics

13 Aug
4:00pm
A1

David Jacome
Saint Peter's University

The way we communicate with each other is changing each day. We have gone from face to face interactions using the World Wide Web on Desktop computers, to using smart phones for Skype or Facetime, and recently having watches send replies to each other in a matter of seconds. If we traveled back in time to the 1950s and spoke directly to people about the future, they would probably respond by saying, I would never expect a person to see another person live on a television screen. Even growing up watching Willy Wonka and the Chocolate Factory, nobody would have imagined during the scene when TV boy is transported to a small screen disappearing in front of everyone. Today, I will tell you a story of how outreach and physics education will be done in 2020. Just imagine sitting in a classroom by yourself, with no classmates or even a professor.

Plasma Physics

Experimental examination of the effect of Resonant Magnetic Perturbation on the edge-plasma turbulence in fusion devices

13 Aug
4:00pm
B2

Lilla Vanó

Eötvös Loránd University

The tokamak is so far the most developed type of the magnetic confined fusion devices. In a tokamak, the fuel is in plasma state. Special periodic plasma instabilities, the so-called Edge Localized Modes (ELMs) exist in high confinement operational mode. During an ELM significant amount of energy and particle is lost which cause large damage on the plasma facing components. But the ELMs also have advantages, such as throwing out impurities. Thus mitigating the ELMs and their negative effect is crucial for a future fusion reactor, like ITER.

There are some methods that are considered to fulfill this task in a tokamak. One of these methods is the Resonant Magnetic Perturbation, during which the magnetic field at the edge of the plasma is perturbed. Previous experiments and studies have shown that it can decrease the amplitude of the ELMs or even suppress them in some configurations. However, the effect of the RMP on the turbulence of the plasma is needed to be examined more to understand it. This is crucial for its optimization for ELM mitigation. In my work I examine how it changes the density fluctuations at the edge of the plasma in both low and high operational mode.

There is a 2D turbulence imaging spectroscopy diagnostic for magnetic confined fusion devices, called Beam Emission Spectroscopy, where the measured data is proportional to the local density. Thus its results are suitable for researching the density fluctuations and the turbulence. Data from this diagnostic was examined mostly.

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13 Aug
4:15pm
B2

Plasma facing materials in thermo nuclear fusion reactors: retention of nuclear fuel

Bogdan Butoi
University of Bucharest

Nuclear fusion has been found to be one of the most promising methods of creating clean energy, in order to satisfy future needs both in terms of a clean environment as well in energy generation and consumption. Scientists for the XX century said nuclear fusion will be ready for public use very soon and although we came a far way and succeeded in creating fusion devices, there are still big problems in maintaining the reactions needed to have a energy output. In this paper, some of the physics and engineering problems found in tokamak fusion reactors are presented, such as the use of materials that could withstand the harsh environment inside the reactor as well as methods used to simulate processes that occur. Using different deposition methods, we investigate material depositions (as found in the reactor) to determine solutions for cleaning the reactor and desorbing the nuclear fuel trapped in the walls.

Quantum Physics and Technology

Introduction to quantum correlations

10 Aug
9:30am
A3

Maria Gieysztor

Uniwersytet Wrocławski

Considering composite quantum systems one can ask whether the system behaves in a quantum or classical way. This is related to the kind of correlations between their subsystems. In my presentation I will start with introducing the classification of composite quantum systems and in the following parts I will elaborate mainly on the quantum correlations. I will explain the notion of quantum discord as a measurement induced informational measure of quantum correlations and discuss its properites. Moreover the geometric approach to quantum discord will be presented along with its properties and consequences

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10 Aug
9:45am
A3

The Components of an Integrated Quantum Optics Network

Marco Canteri
University of Trento

This talk will introduce the elements of an integrated quantum optics network, with an emphasis on the basic blocks such as waveguides and microresonators. In particular I will focus on microresonators where the electric field is enhanced and a lot of energy is stored inside. This feature can be exploited in order to produce a wide range of interesting and useful non-linear optical effects which will be described as well as their applications in the field of quantum technologies.

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10 Aug
10:00am
A3

On-Chip Quantum Optics in One-Dimension: Single Molecules coupled to a Dielectric Nanoguide

Dominik Rattenbacher
Friedrich Alexander University Erlangen-Nuremberg

Over the past two decades conventional light-matter interfaces as optical high-finesse cavities, plasmonic field confinement or high NA-objectives have been used to study the interaction between photons and quantum emitters down to the single quantum level. There is much interest to extend the current techniques in order to assemble networks out of several coupled quantum emitters, since they would give access to study a wide range of interesting quantum many-body phenomena, e.g. the Luttinger liquid of photons, quantum phase transitions in photons or a quantum-optical Josephson interferometer. However, the controlled assembly of more complex quantum optical networks poses many experimental challenges. Here, subwavelength waveguides (nanoguides) with a highly confined guided mode provide a one-dimensional optical bus for coupling many quantum emitters to the same photonic mode. Through their high quantum efficiency and their stable spectral properties organic dye molecules are ideal components of an optical network. We will introduce the spectroscopy of single molecules and discuss the coupling of molecules to a nanoguide. Recent experimental results concerning the coupling strength and the tuning capabilities will be presented. Furthermore we will give an outlook for further experiments containing nanoguides with additional resonators or Bragg mirrors.

Quantum Optics and Plenoptic Imaging

10 Aug
10:15am
A3

Giovanni Scala
University of Bari

The main area is Quantum Optics, specifically some applications in plenoptic imaging. For example, such could improve some technical specifics of field cameras, focusing on some mathematical tools, such as correlation functions, which are applied in experimental requests. This is an example of how our paradigma to do science is not before theory and then experiment, or viceversa, but it is a superposition of them. Managing entaglement and quantum measurement we can "kill two birds with one stone", but let me say "save a couple of lovers that were breaking up". But, don't tattoo it, please!

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10 Aug
10:30am
A3

Optical space-time duality in quantum applications

Filip Sośnicki
University of Warsaw

Optical space-time duality arises from the mathematical equivalence between paraxial diffraction of beams confined in space and the temporal dispersion of optical pulses during propagation in dielectric media. Going beyond the immediate parallels of diffraction and dispersion, the duality indicates that many spatial optical elements, for example a lens, have temporal counterparts realized by applying appropriate phase shifts to the waveform in the time domain. Temporal imaging has predominantly been applied to the measurements of ultrafast optical waveforms by distorsionless magnifying or Fourier transforming the waveform and thus allowing to probe its temporal or spectral features with slow electronic measurement devices. Beyond waveform characterization, temporal imaging systems have the potential to achieve lossless spectral bandwidth conversion of single-photon wavepackets. It is an important element, necessary to realize optical connections between quantum system with a wide variety of characteristic bandwidths. For example, between a wavelength-division-multiplexed channel with a 50 GHz bandwidth, and atomic quantum memories with absorption lines of single MHz bandwidths. During this presentation I will derive the optical space-time duality and present a realistic implementation of time lenses and results of simulations of the single-photon bandwidth converter.

Squeezed light: Going beyond the quantum noise

10 Aug
10:45am
A3

Lamborghini Sotelo
Universidad Autónoma de Baja California

What is a squeezed state of light? We know that a coherent state of light is that which holds the lowest indetermination in the measurement of its quadrature (position and momentum) according to Heisenberg's uncertainty principle. This means that both of the variances if its quadrature have the same value and their product gives us:

$$\Delta x \Delta p = \frac{1}{2}\frac{1}{2} = \frac{1}{4}. \tag{1}$$

We then say that a state is squeezed if the variance of a quadrature is below the variance of a coherent state (or the vacuum state) at the expenses of an increment in the variance of the conjugate quadrature. In order to characterize this kind of states we appeal to homodyne detection. Homodyne detection consists on using a strong and well known local oscillator which is combined with the state under study by using a beam splitter. Then by subtracting the intensities registered from two photodetectors and using photon statistics we can reconstruct the density matrix of the state under study. It is of great interest to our group to generate and characterize non-classical states of light, particularly squeezed states. For this purpose we are working on the implementation of a homodyne detection system that will allow us to have a full characterization of the states implemented in our laboratory: squeezed states generated through Spontaneous Four Wave Mixing (SFWM) in optical fibers and hybrid continuous entangled states.

13 Aug
3:00pm
A3

Applications of ac+dc driven Frenkel-Kontorova model

Sonja Gombar and Nemanja Micić
University of Novi Sad

The Frenkel-Kontorova (FK) model is a simple discrete model, in which competition between interactions determines ground state energy. When FK model is subjected to external driver, it has a wide range of applications in physical systems such as charge and spin density wave systems, irradiated Josephson junction arrays, vortex matter etc. In this work some generalization of this model will be used in order to match experimental results in mentioned type of systems.

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13 Aug
3:15pm
A3

Asymmetric Quantum Systems in Strong Electromagnetic Fields as Terahertz Radiation Sources

Piotr Gładysz
Nicolaus Copernicus University

In the last couple of years, technologies based on terahertz radiation have become increasingly interesting due to their numerous applications in fields such as medicine, biotechnology, material engineering and even history of art. For all of these applications, it is essential to use efficient and tunable sources of terahertz frequencies. This presentation is about quantum systems with broken inversion symmetry subject to a strong electric field, which can be used as sources of terahertz radiation. A two-level quantum system characterized with inversion symmetry and coupled to a classical electromagnetic field undergoes so-called Rabi oscillations where the population flips

between the ground and excited levels. I will discuss how the dynamics is modified if a system of broken inversion symmetry is exploited instead. Then, the eigenstates are characterized with an extra electric dipole moment originating from the polarisation of charges, which plays a significant role. Apart from Rabi oscillations between the energy levels, additional effective oscillations of eigenenergies of these levels can be identified. I will demonstrate how this leads to radiation emission not only at the transition frequency of the system but also with the modified Rabi frequency. The latter could reach the terahertz domain if the quantum system is driven by strong electromagnetic fields, e.g. at close vicinity of plasmonic nanostructures. Final goal is to propose a plasmonic device that could be exploited to implement the above-descibed scenario.

Microscopic System For High Power Laser Sport Diagnose Using The Third Harmonic

13 Aug
3:30pm
A3

Petrisor Gabriel Bleotu
University 'Politehnica' of Bucharest

The technology for developing high power lasers (> 10 TW) and the future state of the art facilities such as Extreme Light Infrastructure-Nuclear Physics 10 PW (ELI), must be able to respond to all the problems which may occur in such types of lasers, such as the amplification or beam propagation. One of the studied problems is the monitoring and diagnosing of the beam profile using the intensity pattern of the focal spot generated at the interaction with a target. This procedure provides information which can be used to check the maintenance of beam quality and also its focusability. The generated intensity can belong to 1019 Wcm^{-2} - 1024Wcm^{-2} hence, making it impossible to use a CCD camera or other devices. Here we present a method for characterizing the spatial profile of such a laser focal spot by imaging the interaction of the beam with a solid target using the third harmonic (3ω). The third harmonic is very useful because it preserves the intensity pattern of the fundamental wavelength while allowing the information to be collected by a conventional camera. The experimental setup includes: a femtosecond laser, the solid target, filters for the fundamental wavelength, two parabolic mirrors, an optical setup designed to collect and magnify the laser beam and a CCD camera. Due to the large diameter of the laser beam (approx. 550 mm), two parabolic mirrors with different focal lengths, positioned at a specific angle, are used to collect, redirect and narrow the beam, such as it can be collected by a magnifying optical system and then by a CCD camera hence obtaining the intensity pattern of the focal point which is properly analyzed in order to get the right experimental setup for future experiments.

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13 Aug
3:45pm
A3

Measuring the Intensity Profile of a Laser Focus by the Fluorescence of Quantum Dots

Tobias Messer
Karlsruhe Institute of Technology

3D printing is an emerging field both in the macro and the nano scale. Especially while working in the nano scale, there are a lot of limiting factors for resolution. One thing to improve is the usage of two-photon absorption followed by the combination of two-photon absorption with the STED mechanism we know from high resolution microscopy. This means there is one first laser with a common gaussian focus which excites the photoresist via two photon absorption followed by a delayed second laser with a different wavelength. The phase of the second laser is modified the way that for example a donut shaped focus arises. In this case, one of the limiting factors concerning resolution is the shape of the intensity profile of the second laser focus. Therefore, we are proofing the widely used method of measuring the profile via reflection on gold beads ($\sim$ 100 nm) as well as setting up a new one. In this new method, we are measuring the profile by measuring the fluorescence signal of quantum dots (6 nm) with a confocal microscope. In my talk, I will show you disadvantages of the old method together with results of the measurements.

Theoretical Physics

Special Theory of Relativity and the Isotropy of the Speed of Light

13 Aug
9:30am
A1

Michał Dragowski
University of Warsaw

The assumption of constancy and isotropy of the speed of light was laid by Einstein at the foundation of the special theory of relativity. This assumption corresponds to one particular clock synchronization procedure, while an equivalent description of relativistic phenomena may be achieved using other conventions. A common misconception regards the possibility of experimental verification of this assumption. It can be easily shown that it is impossible to measure the one-way velocity of light using the direct (time-of-flight) method, as it can only be measured over a closed path. The lack of understanding of the above described concepts leads to a wrong interpretation of the results of Michelson-Morley type experiments, which will also be discussed. Finally, taking advantage of the freedom to choose a clock synchronization convention, a synchronization procedure resulting in absolute simultaneity will be presented, following the work of J. Rembieliński. Such formalism is completely compatible with the Einstein's formulation (i.e., gives the same description of physical phenomena), while providing that events simultaneous in one reference frame remain simultaneous in other reference frames. Such formulation not only allows for a convenient description of many relativistic phenomena, but is also fully consistent with the quantum theory

owing to the fact that the spatial position does not participate in the time component transformation between two reference frames.

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13 Aug
9:45am
A1

Time, simultaneity and synchronization

Adrian Solymos

Eötvös Loránd University

Time is a fundamental feature in almost all physical theories and models. We treat time as if it was a self-evident, intuitive structure of our reality: We talk about time points and time intervals without properly differentiating between them. There is proper time (local) and synchronization (global), notions that may seem interchangeable. We also measure the speed of light between two different points in space to be constant without realizing that instead of making a measurement we are accepting a convention: the Einstein synchronization. The talk wishes to clear up these concepts and if possible may cover some paradoxes that arise from the ill-definedness of these. A mathematical model of flat spacetime developed in the book 'Spacetime Without Reference Frames' by Tamás Matolcsi will be used as the framework of the talk. The non-relativistic and the special relativistic case will be presented.

Geometric description of Hamiltonian-constrained systems

13 Aug
10:00am
A1

Aleksandra Środa
University of Warsaw

In General Realativity Theory, evolution of systems in which gauge transformations are given by the Hamiltonian requires additional structure apart from the one formulated within the standard framework. The aim of the talk is to present geometric description of Hamiltonian-constrained systems and show applications of analysis of sample physical problems. Two examples are analyzed: the dynamics of a free particle in the Minkowski spacetime (in both inertial and noninertial reference frame) and the de Sitter spacetime (in two and three dimensions).

Ghost free actions in multimetric gravity

13 Aug
10:15am
A1

Daniel Blixt
Stockholm University

There are spin-2 field theories with an action structure containing more than one metric and these theories might challenge general relativity. These theories are called multimetric gravity or multigravity (bimetric gravity and bigravity when the action contains exactly two metrics). I will give an overview of actions which are, or might be ghost free. The multimetric gravity theories contains more than one propagating spin-2 field. I will briefly talk about the cosmological implications we can get from these theories.

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13 Aug
10:30am
A1

Causal Dynamical Triangulations Quantumgravity

Dániel Németh

Eötvös Loránd Science University

Causal Dynamical Triangulations (CDT) is a non-perturbative quantum field theory of gravity via a lattice regularization, based on Regge Calculus and Wilsonian renormalization group. The theory bypassing the usual renormalizational problems of gravity with a very elegant way. It is also specific for the theory, that in 2 dimensions it forms an analitically solv- able theory, while in higher dimensions only numerical simulations, such as Monte-Carlo, can lead to results. The basics of the theory is quite simple. In d-dimension (usually 2,3,4) d-dimensional simplices filling the Manifold (universe), so triangles, tetrahedrons and pentachorons creating a Triangulation. As a counter to other theories, time playes a different role, not as a parameter, but as a foliation of the d-1 dimensional spatial Triangulations. During the Monte-Carlo simulations these triangulated Manifolds as configurations can be examined. Analyzing the configurations information connected to the Einstein-Hilbert Action can be extracted. The CDT theory has a very specific phasestructure of the bare coupling constants, that seems to be independent from the topology of the Universe.

The Hypothesis of Perpendicular Time

13 Aug
10:45am
A1

Manik Dawar

Amity University

Based on two assumptions, the consequences on the relative motion of a system's constituents as a function of its uniform velocity are discussed. The system is similar to a "box and ideal gas" system. The first assumption is the existence of a maximum speed at which the constituents of the system can travel relative to any observer at a given instant. The second assumption is that $v/l = v'/l'$. v is the velocity, which a given constituent (initially at rest) of the system attains when it is acted upon by a given impulse. l is the speed limit, the existence of which has been assumed. v' is the velocity attained by the same object (constituent), initially travelling at a constant, non-zero velocity relative to the observer, but at rest relative to the frame of the system, when it is acted upon by the same amount of impulse. l', for a given direction, is the maximum speed which any constituent of the system can attain relative to the system, but measured by an observer who is not stationary relative to the system. From the equation of the second assumption, two expressions v/v' are obtained, the possible implications of which are then discussed.

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12 Aug
9:30am
A1

The uncertainty principle for energy and time

Kasia Budzik
University of Warsaw

The Heisenberg uncertainty principle is a mathematical statement that gives the lower bound on the accuracy with which two observables, like x and p, with non-commuting operators can be measured. One would hope for a similar relation for energy and time. We have an energy operator, the Hamiltonian, however, there is no time operator, since it's existence would have non-physical implications. Nonetheless, the uncertainty relations between energy and time appear frequently in physics, for example in the relation between the lifetime and the energy spread of a state. I would like to talk about different ways to derive and interpret such uncertainty principles, for example by defining particle's arrival time distribution.

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12 Aug
9:45am
A1

Multipartite entanglement using matrix product state approach

Mihály Máté
Eötvös Loránd University

Due to the Nobel prize in phyisics in 2016 the Haldane phase has became focused in the field of topological phases and strongly correlated systems. The simplest model showing the properties of this special phase is the widely studied *bilinear-biquadratic model* in a given range of the phase space.

$$H = \cos\theta \sum_i \mathbf{S}_i \mathbf{S}_{i+1} + \sin\theta \sum_i (\mathbf{S}_i \mathbf{S}_{i+1})^2$$

At a special point this model, known as Valence Bond Solid or AKLT model (after Affleck, Kennedy, Lieb and Tasaki), is integrable and its ground state gives the simplest structure among matrix product states (MPS). Analysing these kind of quantum systems the most powerful method is the density matrix renormalisation group (DMRG) algorithm which inherently represents the structure of MPS. Pair correlation and entanglement of spins are fundamental notions to study in strongly correlated systems, however, *multipartite correlations* can offer a much more essential and evident framework. In my work the bilinear-biquadratic and the $J_1 - J_2$ Heisenberg model is investigated with the methods of multipartite correlations and entanglement using analytical techniques and DMRG algorithms. The exponents for multipartite correlation are determined in the different intervals of phase space (e.g. critical-, dimerised-, Haldane phase).

Symmetries and integrable systems

12 Aug
10:00am
A1

Mikheil Sokhashvili
University of Tbilisi

This talk is about importance of symmetries. I will present 2 different potentials and will investigate the motion with classical mechanics and quantum theory as well. One of this potentials just reflect particles, in second case (deformed oscillator) we get oscillation. Symmetries help to construct conserved quantities also called, dynamical integrals (DI). In quantum theory using symmetries we can solve Schrödinger equation. My goal is to introduce fermionic degrees of freedom and describe a supersymmetric extension of this model and of its higher dimentional analogs. I have not done this part yet, but I am working on it and it will be ready for the conference.

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12 Aug
10:15am
A1

An introduction to supersymmetry

Jan Peter Carstensen
Hamburg University/DESY

The purpose of this talk is to give a quick introduction to supersymmetry. I will focus on mathematical and formal aspects rather than phenomenological ones. Building on this I will motivate why supersymmetry is an interesting topic to study regardless of whether it is realised in nature.

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12 Aug
10:30am
A1

Polyakov Loop extension to Yang-Mills Thermodynamics

Valeriya Mykhaylova
University of Wroclaw

Effective Polyakov-loop models are known as macroscopic approaches to pure SU(3) gauge theory. Such an extension of Yang-Mills theory gives thermodynamics which has a good agreement with lattice gauge theories. The main goal is to derive the thermodynamic potentials in the SU(3) pure Yang-Mills theory in the presence of a uniform gluon field within the background field method. An effective gluon potential is formulated in terms of the Polyakov loop. During the presentation I will show that in extended Yang-Mills theory at low temperature an unphysical thermodynamics of gluons appears and therefore a hybrid approach is needed. The results for more realistic description of QCD thermodynamics with quarks will be also discussed.

Physical applications of Poisson and symplectic reductions

12 Aug
10:45am
A1

Julia Lange
University of Warsaw

This talk is aimed to be an introduction to Poisson and symplectic geometry. Special attention shall be paid on describing the so-called Poisson reduction, which allows us to project a Poisson structure with certain symmetries onto a new Poisson structure on a quotient manifold. As an application, we will address the use of Poisson and symplectic structures and their reductions to systems of physical interest, e.g. a particle in a magnetic field.

Poster Presentations

Astrophysics, Cosmology and Space Physics

Hα Categorization and Radial Velocities of Low Mass Stars

Erik Johnson

University of Göttingen

Low-mass stars are the most numerous stars in the galaxy and are very promising candidates for exoplanet surveys. These stars, however, are subject to a radial velocity jitter that has proven problematic for these surveys. It is thought that since these stars tend to have high levels of stellar activity that the stellar activity caused the radial velocity jitter. When we were investigating this, using Hα as an activity indicator, there was no evidence for a stellar-activity induced radial velocity jitter. However, we found that the spectra of the 176 CARMENES stars surveyed could be placed into four categories ? absorptive, neutral, intermediate and active. The exact ordering of the activity levels between these categories are still in question.

Probing inflation with gravitational waves

Philip Sørensen
University of Southern Denmark

We will investigate how precise models of inflation can be probed through the imprint of primordial gravitational waves in the Cosmic Microwave Background (CMB). Gravitational waves are generated by quantum fluctuations during inflation, with an amplitude proportional to the energy scale of inflation, and subsequently imprinted in the polarisation of the CMB. The aim of this presentation is to understand how precise measurement of the CMB polarisation can teach us about the energy scale of inflation, and to understand the precise physics involved in how gravitational waves gets imprinted in the polarisation of the CMB. The presentation is based on a bachelor thesis written by Philip Sørensen and supervised by Martin S. Sloth of the Centre of Cosmology and Particle Physics, SDU.

An observational study on the origin of cosmic rays

Yigit Sonmez
Koç School

In this study, the origin of cosmic rays is studied by performing Chandra and XMM-Newton analyses of supernova remnant Cassiopeia A (Cas A). In order to point out the origins of cosmic rays, I also explained steps of stellar evolution. With the origins of high-energy cosmic rays still in doubt, I hypothesized that the sources of these high-energy cosmic rays are at the shells of supernova remnants. X-ray images are created using Chandra and XMM-Newton observations of Cas A. Ds9 tool of HEASARCH is used make extensive structural analysis and emission from inner and outer regions of the SNR. Shell sites are investigated in detail and spectra for selected regions are extracted and commented upon. Cas A is analyzed at different X-ray energies from 0.2 to 8 keV and comparison of images is done accordingly. Comparisons clearly show that shell region of Cas A is responsible for hard X-ray emission which provide mechanisms to accelerate cosmic ray particles through the universe. Also, these possible mechanisms are discussed and related with the results.

Study of efficiency of the ORTEC Detective-EX-100T

Maria-Larisa Ganea
University of Bucharest

Gamma-Ray Spectrometry is a fundamental measuring technique commonly used to obtain experimental information on unambiguous nuclear structure. Its advantage lies on the fact that is a non-destructive technique. In order to identify the unknown radioactive nuclides, the process requires instruments with excellent resolution and also reasonable efficiency. Gamma-Ray Spectrometry with HPGe detectors are used for the determination of the radioactive concentration of the radionuclides that can be found in the environment. We investigated the efficiency of the ORTEC Detective-EX-100T using standard gamma-point sources set composed by $_{133}$Ba, $_{152}$Eu and $_{137}$Cs. The main advantage of the detector it's the performance in the rapid identification of radioisotopes. Futher, the efficiency calibrations were performed for three different geometries: 10, 15 and 20 cm distances from the end cap of detector. The study revealed that significant deviations in the efficiency are

depending on the source-detector distance and photon energy.

X-ray Investigation of SNR Tycho Using Chandra Analysis

Mustafa Bozkurt

Boğaziçi University

Supernova remnants are high energy sites in the universe. In this study, a shelllike SNR Tycho are analyzed using its Chandra observations. X-ray study of Tycho is performed using Ciao 4.7 and XSpec softwares. Inner and other regions of Tycho are studied at three different energy bands which are 0.2 - 1.5 keV (soft), 1.5 - 2.5 keV (medium) and 2.5 - 8 keV (hard) respectively. Shell sites of the SNR show hard X-ray dominated observational properties. Inner regions of Tycho reveal a high soft X-ray profile in which spectral analyses show sharp Si and Fe lines. Also, comparison of the selected region is done at different energies and possible sources for high-energy particles with effect of inverse Compton and Synchrotron emissions are studied.

Excitation of a Type-II radio bust during the early expansion phase of a solar eruption

Federica Frassati
University of Torino

The formation of coronal shock waves is usually observationally identified by the presence of a Type-II radio burst; nevertheless, the association between shocks and different possible drivers (flares and/or expanding eruption fronts) is not fully understood. In this work we investigate the early expansion phases of a limb Coronal Mass Ejection (CME) in order to relate the inferred kinematical properties with the observed Type-II radio bust. Background plasma densities were derived in the lower corona with SDO/AIA EUV images analyzed with Differential Emission Measure technique, and in the intermediate corona with SOHO/LASCO VL images analyzed with inversion of polarized brightness. The same data were used to infer the kinematical properties of the expanding CME front, in order to compare the expansion speed with local Alfvén speed. Results show that the shock is likely excited at the same time at different inclination angles along the front, independently on the front projected altitude, also in agreement with the Type-II bust timing. Possible implications for this result on SEP acceleration are also discussed.

Spectrum of cosmological Strömgren spheres

Agnes Kis-Toth

Eötvös University

The epoch of cosmological reionization and the nature of the ionizing sources bear fundamental cosmological importance, but are yet unknown. Our knowledge of the classical H II regions around hot stars suggests how this process might have happened. Ionizing sources, whether galaxies or quasars or sources of other nature, embedded in the neutral intergalactic medium (IGM) before cosmological reionization generated separate H II regions, and these regions eventually could have overlapped to ionize the whole universe. We derive the cosmological generalization of the classical Strömgren sphere to to the case of a quasar as an ionizing source in a comologically expanding gas in a Friedmann-Robertson-Walker universe. We estimate the recombination-line spectrum of these cosmological Strömgren spheres emitted by hydrogen atoms that have been formed by captures of electrons into excited levels and that are cascading by downward radiative transitions to the ground level. We show that in the future we might will be able to measure these recombination lines, especially the Lyman alpha and beta lines, using the James Webb Space Telescope which will be launched in 2018.

Automatic processing of gamma ray spectra

Alexandru-Ferencz Filip
University Politehnica of Bucharest

In recent years, the acquisition of gamma rays spectra has become a highly appreciated domain for its broad applications. Gamma ray spectrometry with Ge detectors is an excelent analysis tool, used in many fields of physics, but not always is it easy to obtain an accurate result. The spectrogram of an element is composed of unique areas consisting of gamma rays photopeaks, Compton scattering and the Compton Edge. Most gamma rays spectra photopeaks are overlayed on top of each other, making the reading of the spectra challenging and confusing. A manual calibration for the desired result can be done by the user, but when working with numerous spectra this activity can be taken by an automatic processing application, thus calibrating the overlayed photopeaks and separating them for a distinct reading. In this paper, the chosen programming environment is IGOR PRO, a program that allows for a more detailed and precise analysis through a code that can interpret ovarlaying photopeaks. This outcome is most helpful for instances where the spectra that is registered is contaminated with another gamma ray spectrum from an additional element.

The Magellanic Group

Cristina Mier González

Universidad de Oviedo

The Magellanic group is formed by the famous Magellanic Clouds, two dwarf galaxies which are surrounded by three main gaseous structures: The Magellanic bridge, the Magellanic stream and the leading arm. Its singular location, close to the Milky Way, makes it a unique scenario for dwarf galaxy and satellite-host galaxy interactions studying. In this work I review our current knowledge of the Magellanic System and its components. The technological development of the last decades have made possible the access to further information about the clouds and the gaseous structures surrounding them. This have allowed the development of new theories about their interactions, formation and history. I also summarize the main scenarios which explain the proper motion of the clouds, the disposition of the gaseous structures and the fate of the Magellanic group. In particular, I treat the main scenarios which explain the origin of the Magellanic stream.

The non-linear relation between X-ray and UV luminosity of Quasars: a new "standard candle"

Viola Gelli

Università degli Studi di Firenze

Quasars are among the brightest sources observed in the universe and they have a wide emission spectrum. There is a non-linear relation between monochromatic luminosity in X-rays (fixed at 2KeV) and UV (fixed at 2500 Å) of Quasars. In this work I studied this relation, checking it and looking for its possible applications in cosmology.

Observational cosmology is based on the study of standard candles, i.e. sources characterized by a known luminosity. Through them it is possible to find the luminosity distance D_L (function of the redshift z) and to study its trend (in the so called Hubble Diagram) obtaining important informations about the cosmological models. Such studies are generally performed by using Cepheids and Supernovae as standard candles. We wondered whether it is possible to use Quasars as standard candles, taking advantage of the non-linear relation in the form $\log L_X = \gamma \log L_{UV} + \beta$. They would in fact allow us to study the Hubble Diagram at very high redshifts (up to $z \sim 6$).

I performed an analysis with a sample of 2060 sources, testing this relation and concluding that Quasars represent a powerful tool to estimate the cosmological parameters and to check the models at long distances.

Reheating after primordial inflation

Daniel Lozano

University of Barcelona

In this work, we analyze the hypothesis that the inflation field has an incomplete decay during the inflation and nowadays is the responsible of existence of the dark matter observed. We analyze the decay of a scalar field into photons pairs in the known case of a quadratic potential, and we extend this to the case of a quartic potential. We study the existence of resonances in such models and we analyze their dependence on parameters. We obtain that the resonant momentum k in the quartic models is proportional to $\sqrt{\lambda}\phi_i$ where λ is the quartic coupling and ϕ_i is the initial value of the inflation field. The coupling parameter f instead only affects to the strength of the resonance.

XMM-Newton Study of Abell2597

Isil Selcuk

Boğaziçi University

In this study, I present an analysis of XMM-Newton observation of Abell2597 (RA :23h 25m 19.6s — Dec -12° 07' 27.4"). It located in the local universe (z=0, 0852). Structural properties of Abell2597 using archived data and XMM-Newton analysis tools: SAS. Image analysis of the cluster is performed by DS9 tool of Heasoft and different energy band images are constructed. The mosaic image of Abell2597 is performed by combining soft, medium and hard images. XSPEC tool of Heasoft is used spectral analysis of the cluster which reveals strong

emission lines at the hot gas between the galaxies. Using spectra of Abell2597, emission lines at given redshift are investigated. I try to explain the effects of these abundances within central region on its environment in following states.

Brightness Variation of Seven Young Sun-like Stars from Ground-based and Space Telescopes

Gabriella Zsidi
Eötvös Loránd University

Young stellar object are stars in the early stage of their evolution. They often show photometric variability, which may be due to non-steady accretion from the circumstellar disk onto the star, but other physical processes, such as rotating cold spots or the transit of a dust cloud can also change the observed brightness of the star. Variability is well examined at optical wavelengths, but nowadays more and more infrared data are available as well. The wavelength dependence of the variability carries information on the physical cause of the changing brightness. Here, we examine seven T Tauri-type stars known for their large amplitude variability selected from the Campaign 13 field of the Kepler K2 mission. We use nightly monitoring observations made with the 90 cm Schmidt telescope of Konkoly Observatory. We construct B, V, R, and I-band light curves and investigated the brightness and color variations of our targets, in order to establish the origin of the variability. In order to extend our wavelength coverage, cadence, and temporal coverage, we will complement these data with high-cadence, single broad-band optical filter light curves from K2, and 3.6 and 4.5 micrometer infrared photometry obtained with a nightly cadence with the Spitzer Space Telescope.

Biophysics and Medical Physics

Photoacoustic Imaging (Photoacoustic Image Formation)

Cengiz Hümeyra, Demirtas Dogu
Boğaziçi University

Photoacoustic imaging (optoacoustic imaging) is a biomedical imaging modality based on the photoacoustic effect. In photoacoustic imaging, non-ionizing laser pulses are delivered into biological tissues (when radio frequency pulses are used, the technology is referred to as thermoacoustic imaging). Some of the delivered energy will be absorbed and converted into heat, leading to transient thermoelastic expansion and thus wide-band (i.e. MHz) ultrasonic emission. The goal of PA imaging is to retrieve the local pressure rise p0 inside the tissue. If we know the local optical fluence F, the absorption coefficient μa can then be calculated. In practice, the adjacent fluence F in the tissue is usually comparable, but the absorption coefficient μa differs considerably. For example, blood in the visible light region has much stronger absorption than other components in tissue. Thus, if F is assumed to be regionally homogeneous in anatomic PA imaging, then p0 can be used to directly map the relative absorption coefficient μa. For PACT, the light is expanded to illuminate the whole object to be imaged. PA signals are acquired at multiple locations around the object, either by using a transducer array or by scanning a single-element transducer to simulate an array. Next, back-projecting all the PA data, similar to traditional computed tomography or positron emission tomography imaging, generates PA images of the object. Note that in order to detect PA signals from the same object at multiple locations, a transducer or transducer array with a large acceptance angle is desirable. Several methods are widely used for PA image formation, such as universal back-projection (UBP) and time reversal.

Implantation of depth electrods in stereoencephalography

Felicia Mihai
University of Bucharest

Stereoencephalography (SEEG) methodology is progressively gaining popularity for the presurgical invasive evaluations of drug-resistant epilepsies. The SEEG implantation procedures still represent a challenge due to the intrinsic complexity of the method and the number of depth electrodes required. Presurgical evaluation of patients with drug-resistant epilepsy using stereotactic implantation of depth electrodes is currently the only method for delineating the epileptogenic network and localizing the seizure onset in both zones and its projection of the cortical surface. This method allows to virtually access any cortical and subcortical area, but in order to achieve accurate the 3D spatial sampling, a significant number of electrodes (between 8 and 15, each having 5 to 18 contacts) have to be placed in functionally relevant structures. Those contacts enable us to find the areas where seizures start by connecting them to a device that function as an electroencephalograph. Using the signal registrations taken on a maximum two weeks period, we can find the epilepsy centers and the neurosurgeon can eradicate or sear the area. This methodology allowed successful implantation in all cases, with reduced errors, such as median entry point localization error was 0.78 mm (range of 0.49-1.08 mm) and the target point localization errors were 1.77 mm (range of 1.25-2.51 mm). SEEG is a safe and accurate procedure for the invasive assessment of the epileptogenic zone. By knowing the coordinates of every location points (Arc, Ring, X, Y, Z), the implantation of depth electrodes enable us to record the electrical activity from superficial and deep-seated brain structures, providing essential information in the most complex cases of drug-resistant epilepsy.

Numerical model of lysozyme protein nucleation and growth kinetics

Andrey Sokolovskiy
St. Petersburg Academic University

The solution of many biomedical problems requires detailed information about chemical structures of biological molecules. The main way to obtain structural information about macromolecules is growing crystals and their subsequent study by X-ray analysis.

To date, there is no model that satisfactorily describes the process of nucleation and crystal growth in the capillary. This research is applied for creating numerical model describing crystallization kinetics in the counter diffusion experiments. The major feature of the problem is the inability to use Fokker-Planck equation for the distribution function, like in most crystallization problems. This is due to the fact that we have seen in the experiment very small number of crystals and it's possible to describe crystallization kinetics for each protein crystal individually. In this research the artificial neural network with backpropagation algorithm has been used for predicting protein solubility as a function of temperature, pH as well as precipitant and buffer solution concentration.

The numerical model with good accuracy describes the processes of nucleation and growth of protein crystals for a long time, as evidenced by a series of experiments. This numerical model may be used to predict the optimal conditions for crystallization of various proteins in the counter diffusion method.

Magnetic field reduction and its consequences. Therapy with magnets

Maria-Alexandra Nacu
University of Bucharest

There has been found a strong correlation between the magnetic field variations and the changes in metabolic rate. It has been noticed a considerable reduction of the geomagnetic component, which is a risk factor for health, generating functional disturbances of body systems. The aim of this paper is: researching functional effect induced by the interaction of living systems with magnetic field and revealing the methods of completing the required magnetic field like magnetotherapy with Neodin (Nd).

Identifying Functional Cluster of Genes from Energy Landscapes in Autoencoders for Personalized Therapy in Medicine

Jenny Yang
University of British Columbia

In the pursuit of personalized medicine within oncology, growing attention is being given to machine learning for cancer diagnostics and treatment. Because machine learning is at the interface of theoretical physics and high-dimensional statistics, the accuracy and success of a model may not depend on computational power or algorithm complexity. Instead, it can depend on comprehensively understanding the theoretical dynamics and energies of the data system itself. Our goal is to analyze the energy landscape of our autoencoder model, for purposes of determining which genes carry the most predictive information in classifying different cancer types. We are training an autoencoder to perform dimensionality reduction on a set of 17,688 genes in the human genome. The learning process finds weights over the training dataset that minimize a loss function. The loss function, derived from statistical physics, represents the energy of the model. The training process aims to find a global energy minimum of the system. Looking at which hidden nodes have the strongest output signal, and performing perturbation analysis of these nodes against the input genes will help us interpret predictive and discriminatory genes. While training, we adjust the activation functions (e.g. sigmoid, standard normal) and loss functions (e.g. cross-entropy, mean-squared) to better understand the energy landscape of our model, as well as the characteristics of the training dataset. Understanding the theoretical underpinnings of our autoencoder model is central to determining which genes carry the most predictive information for classifying different cancer types. This is a fundamental task in our current research towards implementing personalized therapies in cancer.

Computational Physics

Determining the structural properties of model fluids by numerical solution of the equations of motion for the Fourier coefficients of density fluctuations.

Bohdan Opryshko

University of Kyiv

The method of collective variables in the harmonic approximation was investigated structural properties of two-dimensional Gaussian model fluid. Internal energy, system of many particles and radial distribution function of model fluids in microcanonical ensemble were evaluated with molecular dynamics method. In order to ensure that the system established thermal equilibrium, the energy value observed at each time step. For two-dimensional models of fluid particles with Gaussian interaction Influence of harmonic approximation to the description of structural properties.

Effects of maximum node degree on computer virus spreading in scale-free networks

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Université Mohammed V, Rabat

The increase of the use of the internet networks favors the spread of viruses. In this paper, we studied the spread of viruses in the scale-free network with different topologies based on the Susceptible Infected and External model (SIE). It is found that the network structure influences the virus spreading. We have shown also that the nodes of high degree are more susceptible to infection than others. Furthermore, we have determined a critical maximum value of node degree (K_c), below which the network is more resistible and the virus computer cannot expand in the whole network. The influence of network size is also studied. We found that the network with low size is more effective to reduce the proportion of infected nodes

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C# as alternative language for computational physics projects development.

Bartosz Fidera
University of Wroclaw

C# is general purpose high level multi-paradigm object-oriented programming language created by Microsoft in 2000 and currently is the 4th most popular coding language world-wide. In many programming fields it is said that C# can match or outperform languages commonly used in computational physics like C++ or Java but even being as popular as it is, C# is rarely seen in science projects. The best way to check statement about outperforming other languages is to

benchmark them by trying the same simulation problem in for each language and then comparing results in terms of execution time, amount of code needed and used resources involving time required to master language enough to write efficient code allowing for basic scientific usage. Then results can be shown in reader-friendly form that will allow for quick check if C# is really good alternative for scientific purpose as it has been said.

Environmental and Atmospheric Physics

Studying saharan dust intrusions using ceilometer and satellite data over Romania

Daniela Zaharia
University of Bucharest

Atmospheric aerosols from both anthropogenic and natural sources introduce large temporal and regional variabilities in the heat balance of the Earth by scattering and absorbing solar radiation, absorbing and emitting terrestrial infrared radiation, and their ability to nucleate cloud droplets. Due to significant impacts on climate and the environment, desert dust is still under scientific debate. This paper presents the results of three study cases of Saharan dust intrusions over southern part of the Romania. For these studies the data base from the Ceilometers located at Magurele and Strejnicu was used. We study cases of aerosol long-range transport were selected for this work. Data for analysis was obtained based on the measurements performed at the INOE measurement site, located in Magurele (44.35 N, 26.03E) in proximity of Bucharest and at INCAS Strejnicu research base (44.91 N, 25.95 E). In order to perform this study case we used complementary forecast and simulation models and ground based ceilometer measurements for both selected sites. The absence of rainfall in Romania was checked throughout the period, both with Hysplit model, and the observations derived from wet deposition

maps from DREAM. This type of study allows to scientists to conclude about the aerosol-cloud interaction and consequently about regional atmospheric radiative budget, important for understanding of climate change.

The downburst phenomenon

Eetu Rimo
University of Helsinki

In 1972 Japanese-American storm researcher Tetsuya Theodore Fujita was was asked to be a part of investigation team to help them find out why Eastern Air Lines Flight 66 crashed on approach to New York's John F. Kennedy International Airport. During his investigation, Fujita discovered that Flight 66 had been a victim of extremely powerful yet unknown weather phenomenon that consisted of downward winds blowing at enormous speeds. Fujita named this phenomenon as the downburst.

Downbursts can appear all across the globe under the right circumstances. In my presentation I will tell about the downburst formation more as well as the damage they can cause. I will also go more into detail about defining different types of downbursts like what is the difference between a dry and a wet downburst. Other terms associated with downbursts that I'll tell about include the small-sized microbursts, similar but larger wind systems called macrobursts, derechos, that are series of downbursts occurring on a long, straight path and the extremely rare and mysterious heat bursts that can rise temperature very rapidly in an instant.

Fluid Dynamics

Pressure variation caused by the propagation of a boat in shallow water.

Abhishek Gupta
Institute Superior Tecnico, Lisboa

The propagation of a boat creates a disturbance in the surrounding region which causes the pressure variation. The pressure distribution caused by the moving boat is summarized in the case of subcritical speed. A pressure measurement system is established and the simulation has been performed. The change in the dynamic pressure coefficient along the length of the ship is obtained.

Materials and Solid State Physics

Triple conducting oxides - synthesis, properties and applications

Iga Lewandowska

Gdansk University of Technology

Triple conducting oxides (TCOs) are materials that are able to simultaneously conduct electrons (or holes) and at least two ionic spicies. This unique feature may be obtained only in a very specific crystallographic structures. The mechanism of conductivity and the synthesis route of TCOs that conduct H^+,O^{2-},h^+ (or e^-) was shown. Electrical and structural properties of this materials were characterized. TCOs have compelling applications in fuel cells, permeation membranes, sensors, electrolysis and electrofuels. In this work focus was put on application as the cathode in fuel cells.

Laser-induced Breakdown Spectroscopy on Contaminated Soil Samples

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University 'Politehnica' of Bucharest

Laser spectroscopy techniques are modern and competitive methods for environmental analysis. Laser induced break down spectroscopy (LIBS), due to its advantages as noninvasive method, real time monitoring, selectivity, is a promising and suitable tool to measure metals in contaminated soils. In this respect, based on the well-known spectra of the heavy metals, a study of the pollutants identification in soil was performed by LIBS. The results indicate the danger to use plants grown in contaminated soils as food, for people but also for animals, but also open the possibility to use specific cultures in contaminated soils as a method for decontamination and soil bioremediation.

Attosecond Pulse Generation Driven by Intense Chaotic Light

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National Technical University Kharkiv Polytechnic Institute

We investigate the effect of noise perturbations on the electron dynamics in the framework of semi-classical three-step model by solving the time-dependent stochastic Schrödinger equation. We demonstrate that the harmonic noise can change the transition probabilities substantially and that its impact depends strongly on the characteristic frequency of the noise. We will demonstrate the conditions under which a resonance-like behavior emerges in the stochastic photoionization process. This noise induced phenomenon is studied for a variety of laser

pulses, from a few optical cycles duration to very long ones, and of varying intensities. Furthermore we confirm that for a weak laser pulse which causes almost no ionization, an addition of a Gaussian white noise to the pulse leads to a significantly enhanced ionization probability. Nevertheless, the general efficiency of the coherent attosecond pulses generation is decreased. Let us consider the behavior of the moving electrons. The presence of the stochastic forcing term in the Hamiltonian makes the quantum evolution nondeterministic. Thus an averaging over a large number of realizations of the stochastic force is required. Suppose that electrons move in phase with the pondermotive wave, and, in the initial instant of time, the electrons of choice realizations are uniformly distributed over phases.

Laser-Interferometric Position Measurement for Scanning X-ray Microscopy

Valerija Music
DESY Hamburg

Modern X-ray nanoprobe beamlines probe local properties of samples with beamsizes below 100nm on a daily basis. Advanced techniques such as ptychography allow to resolve single-digit nanometer features in realspace. Such local information must be attributed to the correct position on the sample. Positioning on the nanometer scale can be corrupted by all sorts of influences; thermal drifts and external vibrations are the most common. We developed a sample position monitoring system using commercial laser interferometers and custom-built ball lens retroreflectors. The acquired positions can be used in a feedback loop or for corrections in post-experiment data processing. The fast sampling rate (up to MHz) allows us to monitor sample motion on all relevant time scales and identify sources of vibrations in our setup.

Magnetic properties and phase transition in transitions metal doped semiconductor

Younes Sbai

Mohammed V-Agdal University, Rabat, Morocco

On the basis of ab-initio calculations and Monte Carlo simulations the magnetic and electronic properties of Gallium nitride (GaN) doped with the transition metal Manganese (Mn) were studied. The ab initio calculations were done using the AKAI-KKR-CPA method within the Local Density Approximation (LDA) approximation. We doped our Diluted Magnetic Semiconductor (DMS), with different concentrations of magnetic impurities Mn and plotted the density of state (DOS) for each one. Showing a half-metallic behavior and ferromagnetic state especially for $Ga_{0.95}Mn_{0.05}N$ making this DMS a strong candidate for spintronic applications. Moreover, the magnetization and susceptibility of our system as a function of the temperature has been calculated and give for various system size L to study the size effect. In addition, the transition temperature was deduced from the peak of the susceptibility. The ab initio results are in good agreement with literature especially for ($x = 0.05$) of Mn which gives the most interesting results.

CdTe nanowires: preparation and properties

Melania Loredana Onea

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Nanostructures are of great interest due to many reasons. By reducing the dimensions from bulk to nanostructures one can consequently shrink the dimensions of a device and obtain a better control of its proprieties and a reduction of the used resources. Among the nanostructures nanowires (quasi 1 dimensional structures) have remarkable characteristics derived from their high surface to volume ratio which makes them more sensitive to surrounding stimuli. CdTe is a semiconductor which has applications ranging from solar cells to transistors. Electrodeposition is a suitable technique to obtain CdTe nanowires, one of the advantages of this method being the low cost, the control the compositional characteristics and also the properties of the material being similar to those in more expensive methods. Polycarbonate ion track membranes were used as templates to prepare CdTe nanowires. Morphological (SEM), optical (reflection) and structural (XRD) measurements were performed in order to assess the quality of the nanostructures. Further, in order to investigate the detector/transistor features of CdTe nanowires these were contacted using a combination of methods i.e. of electron beam lithography and photolithography. Thus, electrical properties were measured for individual, tailored CdTe nanowires.

Physical properties of proton irradiated MgB_2

Alina Marinela Ionescu
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Magnetic properties, high field critical current density and pinning characteristics of a series of SPS-sintered MgB_2 submitted to energetic proton (8.6-16 MeV) irradiation are presented. The critical temperatures show only negligible decrease with increasing energy and fluence, whereas the Meissner fraction significantly decreases with increasing fluence and energy. Two characteristics are conspicuous after irradiation: a serious extension of the temperature range where flux jumps are present and an increase of the pinning energy of the irradiated samples at high fields.

Development of a laser lithography system

Alvaro Nodar Villa
University of Santiago de Compostela

The photolithography – laser lithography – systems are becoming a popular element concerning the manufacture of micro and nanometric structures. This work will show the basis of this technique featuring the new Santiago de Compostela University photolithography system developed by the author. Additionally, this work will present the process of manufacturing bidimensional micrometric structures made with this same lithography system. This micrometric structures will be applied to the confinement of light – integrated optics devices – and to the confinement of nanoparticles. Concluding this work, it will be shown measurements of the properties of this devices.

Physical properties of NbSeI compound

Marta Roman
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Although the crystallographic structure of NbSeI compound is known from 30 years, its physical properties are still not described. NbSeI is an isostructural compound to the group of "defected" spinels AB_4X_8 (where A=Ga, Ge or Al; B=Mo, V, Ta, Cr or Nb; X=S, Se or Te). Characteristic feature of crystal structure of these materials are tetrahedral, metallic clusters B_4 determining their physical properties. Increase of correlations between electrons are caused by mentioned unusual building of crystal structure and it leads to the occurrence of numerous interesting physical phenomena, such as structural and magnetic phase transitions, superconductivity under pressure, colossal magnetoresistance, multiferroism or electric-field-induced resistive switching (potential use in new class of memories – *Resistivity RAM*). The occurrence of similar physical phenomena was expected in NbSeI compound. Unusual crystal structure and similarity to the materials with interesting magnetic and transport properties were a direct cause of a detailed examination of the structure and physical properties of NbSeI. Reproducible synthesis method of NbSeI compound, the results of powder X-ray diffraction and the results of physical properties measurements (magnetic susceptibility, specific heat capacity) in the temperature range of 1.9 - 300 K will be presented here.

Floquet-Bloch description of non-adiabatic radiation damage processes

Nicolò Forcellini

University of Cambridge

Damage caused by radiation is a major issue for structural materials in fission and fusion reactors and in many other applications. Understanding how radiation damage caused by high-energy particles occurs is a field of great interest in materials physics, and most of this understanding has to come from reliable theoretical models: the timescale in which radiation damage processes take place is too short to be investigated by experiments. Also, an explicit quantum mechanical treatment of the electrons is especially important for fast projectiles ($E/W \gtrsim 10$ MeV). Starting from some simple and idealised models, e.g. one-dimensional lattices perturbed by a fast projectile, and by exploiting the symmetries of such systems, it is possible to build a Floquet-Bloch description of non-adiabatic radiation damage processes. Such a general theory can be used for both a qualitative understanding of such processes and, hopefully, as an implementation to improve efficiency and reliability of existing simulation models such as TD-DFT.

Functionalized gold nanorods at air-water interface

Agnieszka Wiciak
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Gold nanoparticles deserve attention due to their unusual physical properties. Characteristic for colloidal solution of gold nanoparticles is strong color, which is caused by the surface plasmon resonance. Gold nanorods (Au-NRs) were synthesized with seed mediated growth method described elsewhere. Cetyltrimethylammonium bromide-coated Au-NRs dispersions are stable in aqueous solutions. The problem is to transfer them into organic solvents, because the layer structure of the surfactant on the gold nanorod surface impedes the access of phase transfer reagents to the surface. In this work we have shown how to change nanoparticle properties to hydrophobic by silica coating. This method facilitates the manipulation of the Au-NRs, reduces aggregation and in addition preserves their optical properties. In the next step we have produced and characterized thin films from functionalized Au-NRs dispersed in chloroform at air-water interface. For this aim, we used the Langmuir technique. This method allows organize and manipulate the materials organization at a molecular level.

Acknowledgments:
This work was supported by the Ministry of Science & Higher Education in Poland in 2017 year under Project No 06/62/DSPB/2171.

Comparative study of the effects of rare earth ions doped $BiSrFeO_3$ nanomultiferroic

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Nanomultiferroic materials have increased significantly over the years in view of their projected potential applications in sensors and recording media. Multiferroic materials are singlecomponent materials or composites exhibiting two or more ferroic features such as ferromagnetism, ferroelectricity, or ferroelasticity effects. Recent resurgence of research interest for multiferroic materials revived the possibility of strong coupling between the magnetic and ferroelectric order parameters of some promising materials and are likely to be used around room temperature (RT) for possible device design and applications. BiFeO3 (BFO) is the most interesting magnetoelectric multiferroic compound and has attracted considerable attention because of its ferroelectric and anti-ferromagnetic ordering coexists in a single phase at room temperature. We argued that the addition of rare earth is likely to suppress the spiral spin modulation and at the same time increased the canting angle which favors the enhanced ferromagnetism, that BSFO showed antiferromagnetic behavior, but for the BSREFO exhibit a weak ferromagnetic behavior with remnant magnetization of highest value for Y3+ (Mr =0.43 emu/g).Electrical properties were measuredand the temperature dependence on thedielectricconstant and temperature dependence onthe electrical conductivity (σac), at different frequencies ranging from 100Hz to 100 kHz for undoped and doped nanomultiferroics were recorded.A noticeable improvement in conductivity after theNd rare earth doping due to its higher transition temperature for (Tσ =760 K) than the undoped BSFO sample.

Ferromagnetic nanoparticle of Ising spin-1 with a Rubik's cube structure: Monte Carlo simulations

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Rabat University

Using Monte Carlo simulations, magnetic properties of the ferromagnetic nanoparticle of Ising spin-1 are investigated in the framework of the Ising model. The system is assumed to have a Rubik's cube structure where cubic structures blocks are ferromagnetic systems having an equivalent exchange coupling, while, between blocks, the exchange coupling is considered to vary. On the one hand, size effects of cubic blocks, consequently, of the nanoparticle on phase diagrams of the system are studied. On the other hand, the dependence of magnetic behaviors on system parameters is investigated. Thus, we follow variations of quantities such as the magnetization, the magnetic susceptibility, the hysteresis loops and the critical temperature in order to explore phase diagrams of interest.

Ultrathin colloidal CDSE nanoplatelets for black light emitting devices

Tatiana Kormilina
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While radiation sources based on colloidal semiconductor nanocrystals are currently a high demand, they do not cover the whole range of possible applications due to insufficient spectral diversity. Among these nanocrystals flat two-dimensional ones, called nanoplatelets have recently revealed a great potential as optical gain media. Optical characteristics of nanoplatelets favorably distinguish them from other nanocrystals by a narrow

luminescence maximum and almost absent Stokes shift, which makes them promising for creating effective narrow-band light emitters. Indeed, for platelets it is easy to obtain the radiation of the desired wavelength, this is achievable by low-cost methods, and the resulting colloidal solution is very convenient for insertion into matrices and the creation on their basis of various multicomponent systems. The major drawback that prohibits for now the use of thinner nanoplatelets in the optoelectronic applications is the fact of their optical properties still being poorly understood, and, mainly, of the information about the kinetics of the relaxation of charge carriers in these platelets being insufficient. Therefore we developed a stable and repeatable synthesis procedure for obtaining ultrathin nanoplatelets and studied their optical characteristics to show that these nanocrystals will allow to broaden the line of pure-colored semiconductor light emitters and enrich them with devices operating in UV range, that would be extremely useful for medical lasers, as well as for integrating them in optical fibers, microfabricated waveguides and lab-on-chip systems.

Synthesis, Characterization, Electronic and Optical Properties of The New Double Perovskite $BaSrMgWO_6$: Theoretical and Experimental Study

Abderrahman Abbassi
Mohammed V University

The powder sample of double perovskite oxide $BaSrMgWO_6$ has been elaborated by conventional solid-state reaction. Structural and optical properties of this sample have been investigated. At room temperature crystal structure is face-centered cubic (space group Fm-3m with the unit cell $a = 8.0173$Å). Using the diffuse reflectance UV-visible absorbance spectrum, the optical band gap of $BaSrMgWO_6$ sample is 3.7 eV. Based on Density Functional Theory (DFT), and using full Potential-linearized Augmented Plane Wave (FP-LAPW) method with the Local Density Approximation and the Generalized Gradient Approximation (GGA), implemented in the Wien2k package, we have investigated electronic and optical properties of such material. The optical band gap obtained with GGA approximation is equal to 3.7 eV, which is in good agreement with our experimental results. We found that transmittance T is stable and reaches the average of 80% in both experimental and theoretical studies.

Memories based on ion migration effect

Tomáš Hrbek
Charles University, Prague

Current RAM memories, which are used for example in personal computers, are at the edge of the limits of miniaturization. Thus there is a need of developing new memories that are able break this limit. We are going to present CB RAM memories chalcogenide. These memories are based on creating and destroying of conductive filament in chalcogenide electrolyte between two electrodes. Firstly, we need to prepare chalcogenide glass from the chosen materials. Usually we use some combination of Ag, As, S, Se etc. The layer of the electrolyte has to be thin. To do so we can use various methods as flash evaporation, vacuum evaporation, thermic evaporation etc. Advantages of this memories are for example higher density of stored information due to possibility to store more than one bit of information per one filament, no need of energy to keep written information written and higher resistivity against radiation; as a consequence, there is an option of using them in space. Our goal was to prepare working sample and find out which combination of chalkogenide is most suitable for CB RAM memories. We tested samples which we'd created and we compared the results of measuring with the theoretical predictions.

Production and characterization of galwanotechnichnical layers on the basis of chlorides and metals block D

Joanna Jabłońska
Poznań University of Technology

The world and society in accordance with the latest trends strives to minimize and exclusions of substances having a harmful effects on the environment and living organisms. Both, industry and science, not only search for new technological solutions, but also puts special attention on the implementation of the new standards in the case of commonly used techniques. Thanks to the analysis of the chemical composition of the electrolytic bath, conducting experiments to investigate the effect of chemical composition and concentration of the substance used, it will be possible to extend the fictionalization of electrolyte and reduce the amount of harmful substances needed to obtain the layer. In view of the specific properties of alkaline electrolytic bath, there have been selected elements with a block D, like copper. These elements, which are also called transitional metals, are characterized by an incompletely filled shell d. For the manufacture of thin layers the process of electroplating was applied. Even in this day and age, electroplating is one of the best opportunities to obtain the perfect shell. This process is used, inter alia, in the formation of coatings that prevent corrosion. One of the most commonly used metals during electroplating is chrome, which is primarily used for the coating of tools used in the workshop. Protects metal surfaces chrome from mechanical damage and significantly affects the reduction of adhesion of the tool.

Synthesis and Characterisation of Metal-Silicon Oxides

Ewelina Nowak
Poznan University of Technology

Metal-silicon oxides complexes find more and more applications in functional material engineering. One of the easiest way to produce such material with nanometric precision is sol-gel method, which biggest advantage is its simplicity and relative low process cost, what makes the method great for apply in most fields of industry. Presented method consist stages such as chemisorption of alkoxide, rinsing, hydrolysis and drying. Accordingly, fully crystallized ZnO2, AgO2 and TiO2 materials were synthesized by replacing the hydroxyl group with methyl siloxyl. The main purpose of the work is to characterize the obtained materials in terms of chemical composition, crystalline bonds and crystal structure using Raman spectroscopy mapping. For the analysis of physical properties, microscopic and spectroscopic measurements were carried out using AFM and STM. Due to predicted semiconductor and magnetic properties measurement of I-V characteristic were performed.

An Enhancement Of Photoluminescence From PbS Quantum Dots By LSPR In Semiconductor Nanocrystals

Anton Babaev

ITMO University

The Cu2-xSe nanocrystals (NC) and the PbS quantum dots (QDs) with close frequencies of the localized surface plasmon resonance (LSPR) and the exciton state were applied to observe an enhance of QDs photoluminescence in various organic and inorganic matrices. An important advantage of QDs over organic dyes is that we can use QDs of different sizes thus easily changing the resonance conditions of the plasmon-exciton system. Thus, we observe the different states of the plasmon-exciton system in the strong couple regime. We achieve the 21-times enhancement of the QDs photoluminescence in non-porous silicate matrix after plasmonic NC embedding. In addition, we have observed the change in the shape and position of the PL spectra as well as PL decay time reduction. The non-resonant excitation of this sample shows the same behavior with lower enhancement factor. We believe the change in the spectra is related to the Rabi splitting arising in the strong coupling regime or to the influence of LSPR on QDs radiative states. Thus, our experiment proves the effectiveness of the using plasmonic NC for practical applications and provides a valuable data for basic research.

III-V racetrack microlasers with InAs/InGaAs quantum dot active region

Ildar Nabiullin

St Petersburg Academic University

To improve the coupling between the microring resonator and the output waveguide, insertion of a straight section in the coupling region is utilized (the so-called racetrack geometry). Racetrack microlasers with the radii less than 3.5 μm based on InAs/InGaAs quantum dot active region are fabricated by molecular beam epitaxy and studied under optical pumping by microphotoluminescence method. The influence of the racetrack geometry (outer and inner radii and length of the straight part) on emission spectra and lasing characteristics at room temperature are studied. We have found that FSR decreases with the increase of the straight part of the racetrack. The threshold power increases with the straight section length (L), but it remains quite comparable with microlasers with L=0. Thus, high-quality microlasers with small foot-print and low threshold currents optimized for coupling to bus-waveguides are demonstrated.

Dual Active Galactic Nuclei in Merging Galaxies

Gerard Valentí Rojas

Universitat de Barcelona

Within the modern paradigm of galaxy evolution through hierarchical structure formation, active galactic nuclei (AGN) are believed to be a natural outcome of binary mergers between massive galaxies as they trigger mass accretion into their central supermassive black holes. However, the reported frequency of dual AGN is surprisingly low compared to current estimates on the merger rates of galaxies. In this work, we use idealised simulations of major galaxy mergers to predict what would be their observed fraction when the observational limitations involved into their detection are taken into account. A key ingredient in this modelling is the evaluation of the merger timescale, which can vary substantially with the orbits, halo spins and mass ratios of the merging objects. We propose an alternative analytical expression for this magnitude which, for pairwise mergers, leads to more accurate predictions than existing formulas.

Band bending at surfaces and interfaces: metal-semiconductor contact.

Andreea Serban
University of Bucharest

The growth mechanisms of Pt and Cu on clean Ge(001) substrates were investigated by using ultrahigh vacuum techniques. The crystallinity of the surface was studied via low energy electron diffraction (LEED). LEED patterns do not exhibit long distance ordering. X-ray photoelectron spectroscopy (XPS) was used to investigate the band bending effects at the interface of Ge with the metals. Both contacts presented Ohmic behaviors. Two theoretical models, consisting in the effective mass variation or the conduction band broadening have been created to explain the behaviour of Pt/Ge(001), and both of them were verified by the Cu/Ge(001) contact.

Crystal growth and properties of binary intermetallic $ZrBi_2$

Zuzanna Sobczak
Gdańsk University of Technology

Single crystals of $ZrBi_2$ intermetallic compound were grown by the self-flux method. Phase identity of the crystals was examined using powder x-ray diffraction (PXRD) and patterns were analyzed by means of the Pawley method with the Topas software. Material adopts the $TiAs_2$ structure type with lattice parameters: 10.2334(15) Å, b = 15.581(2) Å and c = 3.9945(5) Å. Crystals of $ZrBi_2$ were studied by means of magnetic susceptibility, specific heat, resistivity and magnetoresistance measurements. $ZrBi_2$ is reveals a metallic-like

behavior (RRR = 30) with high magnetoresistance. The Sommerfeld coefficient obtained from specific heat measurements equals $\gamma = 1.59(16)\,\mathrm{mJ\,mol^{-1}\,K^{-2}}$ and the Debye temperature $\Theta_D = 178(2)\,\mathrm{K}$. Low-frequency Einstein mode with $\Theta_D \sim 40\,\mathrm{K}$ is seen in specific heat.

Assemblies of Thermoresponsive polymers molecules hydroxypropylcellulose and methylcellulose investigated by means of dielectric relaxation spectroscopy

Andrii Ostapchuk

Taras Shevchenko National University of Kyiv

Aqueous solutions of hydroxypropylcellulose and methylcellulose with different polymer concentrations are investigated using dielectric spectroscopy in a frequency range of 10^3 Hz to 10^5 Hz at temperatures from 10° C to 70° C. Assemblies of Thermoresponsive polymers molecules hydroxypropylcellulose and methylcellulose have or lower bound to a temperature range of partial miscibility, that investigated and shown in the diagrams. Relaxation processes in the systems explained by changes in the structure of molecules.

Fabrication of Ni(1.5 nm)/Cr(x nm)/Fe(2 nm) Magnetic Multilayers by PVD and investigation on Cr spacer thickness in oscillation exchange coupling

Kimiya Pakravanan
Ferdowsi University of Mashhad

Ni/Cr/Fe multi-layers were deposited with different thickness of Cr as spacer in pressure of 2×10^{-6} mbar by PVD facility. Structural and magneto-optical properties were investigated. X-Ray diffraction measurement exhibits preferred orientation of Fe(1 1 0), Cr(1 1 0) and Ni(1 1 1) for the multi-layer and increasing in crystallization by increasing in spacer thickness. XRR characterization emphasises the periodic structure of the multi-layers and shows increasing in roughness by increasing in the spacer thickness. Magneto-Optical Kerr Effect (MOKE) measurements indicate the oscillation exchange coupling between Fe and Ni layers.

Structural Properties & Metal Distributions on Abell 754 and Abell 520

Oğuzhan Çolkesen
Koç School

Clusters of galaxies are one of the brightest X-ray resources in the universe. They give pieces of evidence for the questions; how the universe is expanding, how matter is distributed in the space, as well as how gravitational waves are produced. The main X-ray emission from cluster of galaxies is coming from hot gas at the intergalactic regions at the clusters. In this study, Chandra X-ray analysis of two merging clusters of galaxies, Abell 754 and Abell 520 is presented. X-ray structural analysis of these galaxy clusters show the behavior of hot gas between galaxies, which is the main X-ray source, and might help to understand how gravitational waves are created. The ciao 4.7 tool of Chandra X-ray observatory is used to perform the analysis. Spectral analyses of the clusters are done with XSPEC tool of Heasarc. X-ray spectra of Abell 754 and 520 are produced and line emissions are studied to reveal metal distribution at the hot gas between the galaxies. Also in this study, Chandra X-ray analysis of two merging clusters is studied and presented to explain their structures by comparing soft, medium and hard X-ray properties.

Current driven domain wall creation in ferromagnetic nano-wires

Nils Sommer

Johanes Gutenberg Universität Mainz

A central topic in spintronics, i.e. the field in physics where one exploits the spin of an electron in addition to its charge, is the manipulation of magnetic textures by currents. In a recent work it was predicted that magnetic domain walls can be generated in a ferromagnetic nano-wire by means of an electric current once there is an inhomogeneity. In particular the authors focussed on a set-up where the magnetization of the ferromagnetic wire was mainly aligned along the wire. Only the magnetization at one end of the wire was fixed along a perpendicular direction. It has been shown that above a certain threshold current density domain walls are injected into the nano-wire with a period that is controlled by the current strength.

During my Bachelor research we have analysed the influence of the orientation of the fixed magnetization at the end of the wire. We have shown that while reducing the tilting angle the threshold current above which domain walls are shedded is increasing. Decreasing the tilting angle to zero we were able to recover the ferromagnetic instability.

Split & Delay Photon Spectroscopy with Visible Light

Verena Markmann

University of Hamburg

Conventional methods such as Dynamical Light Scattering (DLS) techniques are limited by the framerate of the detector. A double pulse approach for Photon Correlation Spectroscopy (PCS) presents a possibility to overcome this issue. With short pulses provided by an Acusto-Optic Modulator (AOM) determining fast dynamics of colloidal systems becomes possible.

We aim for an automatized setup for double pulse correlation. A rotational motor stage for the detector has already been installed to provide the precision needed for determining the q-range of the measurements. Furthermore a mechanism for additional temperature control of the sample is being designed to examine temperature dependent colloids, for example Poly(N-isopropylacrylamid) (PNiPAM), and other particles with fast and/or complex dynamics.

Materials in flatland: beyond graphene

Aleksandra Bojar
Gdansk University of Technology

Two-dimensional materials exhibit much different properties with comparison to their bulk counterparts. Best-known 2D material – graphene – was first obtain via mechanical exfoliation from bulk crystal (graphite) in 2004 by Andre Geim and Konstantin Novoselov. Scotch tape exfoliation technique, though not being a good method for scalable production, is still the best way to obtain highquality monolayer crystals for scientific research. Graphene, despite its outstanding electronic and mechanical properties, has limited applications due to its zero bandgap. This limitation can be overcome with semiconducting Transition Metal Dichalcogenides (TMDCs), which like graphite are layered materials. Their bandgap can be tuned by changing the number of layers. They exhibit a transition from indirect to direct bandgap when the number of layers decreases down to one layer. This poster focuses on monolayer molybdenum disulphide, obtained via Scotch tape exfoliation method, and its properties characterisation by means of optical microscopy, Raman spectroscopy and photoluminescence.

Linear dynamics for superfluid vortex formation: the case of the "snake" instability of a grey soliton in a two-dimensional Bose-Einstein condensate

Alexej Gaidoukov

Technische Universität Kaiserslautern

The non-equilibrium formation of superfluid vortices in a dilute Bose-condensed gas is a dramatic phenomenon, but its exact description requires nonlinear quantum field theory (interacting quantum many-body dynamics in second quantization). The nonlinear classical dynamics of vortex formation can be described within the Gross-Pitaevskii nonlinear Schrodinger equation, but quantum effects are difficult to compute beyond the simple Bogoliubov-de Gennes linearization. Here we show, however, that vortex formation does not always require nonlinear dynamics. If the vortices form in a region where the condensate density is low, they may appear without significant nonlinear evolution, even though their appearance changes the condensate wave function topologically. We confirm this by directly comparing linearized and nonlinear classical evolution as vortices form from the so-called "snake" instability of a grey soliton in a two-dimensional condensate.

We find that linearized and fully nonlinear evolutions remain close until well after vortices have appeared. This observation opens the door to a fully quantum mechanical description of superfluid vortex formation, within the easily quantized linear Bogoliubov-de Gennes theory of small perturbations around a background mean field.

Spectroscopic characteristics of metalloorganic complexes from the Fetriazole family of compounds

Małgorzata Rudnicka
Gdańsk University of Technology

A part of transition metal complexes with octahedral symmetry has the ability to switch the spin state of their central metal ion. Such effect, called spin crossover phenomenon (SCO), can be achieved by applying external stimuli to those materials. It can be caused by a change of temperature, pressure, electromagnetic radiation, electric or magnetic field. Eventually, spin switching causes alterations in electronic framework of the whole complex, which explains different chemical and physical properties between a low-spin (LS) and a high-spin (HS) state. Both states can be distinguished from one another by measuring their magnetic, optic and structural characteristics. Fe-triazole complexes are a specific type of compounds family exhibiting SCO effect. Their general formula is given as $[Fe(Rtrz)_3]A_2 \cdot nH_2O$, where R – substratum other than iron, trz – 1,2,4-triazole ligand or its derivative, A – opposed ion. In this work three complexes with similar structure were studied: $[Fe(NH_2trz)_3](NO_3)_2$, $[Fe(Htrz)_2trz]BF_4$ and $[Fe(tert\text{-}trz)_2(H_2O)_4] \cdot 2H_2O$. Raman and UV/VIS spectroscopy were used to analyse samples. Raman spectra were obtained by applying laser light at 514 nm wavelength. Wavelength range for absorption spectra was 200-900 nm. During the whole measurement process samples were in powdered state. The research confirmed that at room temperature all three samples are in LS state. Moreover, it helped to establish that the complex of $[Fe(tert\text{-}trz)_2(H_2O)_4] \cdot 2H_2O$ belongs to the Fe-triazole family of compounds with SCO effect.

Scanning electron microscopy methods in study of micro objects

Iuliana Taran
University of Bucharest

The investigation of different materials and objects in the material science and in other fields and technologies requires the use of scanning electron microscope (SEM). As example, it can be shown the use of SEMs in chemistry, material physics, biology and nanotechnology. The aim of this work is the researchers acquaintance with scanning electron microscope and the study of methods for investigating samples using the SEM. During the process of using the SEM it is possible to observe that the samples consist of different materials. In case the nonconductive specimen is investigated it is necessary to cover it with conductive layer. Electron microscopy is helpful for offering information regarding the elemental composition by collecting the X-Ray characteristic radiation spectrum. In this poster it will be also shown some photos with samples like salt particles, natural dark hair, blonde dyed hair, simple eyelash, mascara eyelash which was investigated with SEM and photos with investigation of Z-contrast for different elements like carbone tape, gold layer and copper band.

Density of states calculation with Wang-Landau algorithm

Ana Milinović

University of Vienna

My aim was to try to replicate the results obtained in the original paper. Ising 1D model was calculated first and checked analytically. Second, Ising 2D model was simulated and Wang-Landau algorithm was used to calculate the density of states. Poster will discuss the results and how they agree with the results from the original paper. How algorithm converges will be discussed. Ising 3D and Potts models and calculations will be investigated.

Concept of Volatile Organic Compounds Analyzer for ISS Atmosphere Monitoring

Anastasiya Annenkova

Moscow Institute of Physics and Technology

International Space Station (ISS) Atmosphere is an isolated and regenerated, as a result atmosphere contains many volatile organic compounds (VOC). For example, compounds such as ammonia, Freon or formaldehyde have a great negative impact on astronaut's health. Therefore, a lot of timely control on them in the atmosphere is required. Nowadays, astronauts have special absorbents for accumulation of harmful substances while they are in the ISS. After the homecoming of astronauts, the absorbents were explored in the specialized laboratories using gas chromatography and mass spectrometers. The accuracy of these methods is high, but their complexity and the need for maintenance don‘t allow them to be used in the orbit. The aim of this paper is the development of the ISS atmosphere monitoring system. Spectrometric methods are the most useful for solving this problem. The main problem is that the spectra of heavy organic molecules are not resolved and overlapped. Therefore, it‘s necessary to provide a wide spectral range (8-11μ) to effectively identify individual compounds. Usually this task is solved by Fourier spectrometers. But Fourier spectrometers, which can be used in the orbit, has too low spectral resolution (0,5 cm^{-1}) to resolve individual narrow spectral features. In this paper we propose to use cavity enhanced laser spectroscopy method using cavity quantum-cascade laser (EC-QCL). Modern quantum-cascade lasers can provide a wide spectral range (8-11μ) for hundreds of milliseconds. The laser line width doesn’t exceed a few megahertz, which provides a high spectral resolution (<0,001 cm^{-1}). It is also important to accurately measure the absorption of the continuum due to the overlapping of the compounds spectrums over the entire spectral range. These are the reasons we are going to use cavity ring-down spectroscopy (CRDS) with an effective optical path of 140-280 meters depending on the spectral range. It is early stage project and we present an optical and general scheme of spectrometer, sensitivity estimates and dynamic range on the conference.

Nuclear Physics

Absolute differential cross section for elastic electron scattering on Argon atom

Jelena Vuković
University of Belgrade

This paper presents the results from experimental research of interaction of electron with argon atoms. The goal of the experiment, whose results are presented in this study, was to measure the differential cross section for elastic electron scattering on argon atom in an angular range from 20° to 121°, for incident electron energies 50eV, 100eV, 150eV and 200 eV. The measurements of differential cross section are performed in the function of scattering angle, at a fixed incident electron energy. Measured relative cross sections were brought to the absolute scale with the help of known referent absolute sections by using relative flow method, where as the referent gas was used helium. The results, tabulated and graphically presented, were compared with the results of other autors, where they observed good match for almost all values of scattering angle. The paper describes the experimental settings of device: an electron gun and analyzing system, the experimental measurement procedures for relative and absolute effective cross sections, where special attention is given to the measurement of absolute cross section using relative flow method.

Other Interesting Topics

The amazing life of Physics students in Portugal

Melissa Serra
University of Lisbon

Portugal is now a top touristic destination since most of our coast is made of beautiful beaches and landscapes. We have a great weather and nice people with different unique traditions all over the country. We have a wide variety of fantastic traditional food, our wine *Vinho do Porto* and the unique music style *Fado* is worldwide recognized and prized. What about Physics? And physics students? Our university life is also peculiar. We have the student welcome ceremony and activities called *Academic Praxe* that are unique and do not exist in other countries, academic weeks and a unique student spirit.

In this poster, we would like to discuss how is the physics student university life in Portugal, and to answer the questions of what drives Portuguese young students to follow physics university degrees, what are their main difficulties, interests and hobbies, what is the branch of physics they are interested in for future work, perspectives, etc. Overall, we are hoping to show and share the amazing life that we, physics students, have in Portugal, such a small country at the southwest corner of Europe

Classical musicians and Physics students: one passion, two worlds

Alfonso Lopo
University of Lisbon

Can music be described as a packet of waves with different frequencies created by different instruments? Can we fully reproduce a song with one computer? Being two classical musicians and physics bachelor students, we are proposing to compose an original song using our own instruments, a transverse flute and a cello, play it and recreate it using digital instruments. Our main goal is to show why machines cannot replace a musician, but can really help to better understand and improve our skills and living. In this work, we will analyse the results given by the digital methodologies in term of its spectral analysis and will provide a scientific and artistic interpretation of the results.

The Entropy of Economics: Calculating Economic Inequality through Statistical Mechanics

Anmol Lamichhane
Earlham College, USA

Have you heard of the 1%? Can we use thermodynamics and statistical mechanics to predict and understand economic or other socio-political inequalities that leads to the creation of the 1% class? I present various statistical mechanics models that could be used to better understand such inequalities.

Aramis: data science applied to cyber security

Davide Bernardi, Federica Bisio, Pierangelo Lombardo, Alan Perotti

aizoOn - Technology Consulting

Data science techniques applied to the cyber security domain allow for a novel approach to the detection of many types of anomalies, such as attacks, malware, and users? abnormal behavior; this approach offers new possibilities to better automate the security process. The proposed framework, called aramis (Aizoon Research for Advanced Malware Identification System), detects such anomalies by employing both a human driven and a data driven point of view. The first is realised through a set of advanced cyber security analytics, which automate the analysis of cyber security experts, allowing to automatically and exhaustively analyse companies network data; the latter is implemented via an unsupervised machine learning engine, which is able to build models of the normal behaviour of the network. The two approaches together allow to obtain a complete and detailed information about all kinds of anomalies in the network, thus leading to the detection of risks and threats.

A multidimensional graph approach to workplace analytics

Davide Bernardi, Claudio Borile, Riccardo Rinaldi, Anna Velyka

aizoOn - Technology Consulting

Statistical physics-based models have proven to be a very effective tool to study complex interdisciplinary problems. A particularly challenging and important question is to understand how to extract quantitative information and global patterns from the apparently unstructured and noisy interactions between people in a society. Data-driven approaches and computational methods play a central role in these kind of analyses, due to the probabilistic nature of the underlying “microscopic” processes and the large amount of complex interactions that make analytical approaches impractical. Here we will consider the case of the “Enterprise Social Graph”, where we analyze the topological structure of the network of informal interactions and collaborations within the workplace considered as an open system, combining computational sociology with state-of-the-art quantitative methods to extract global and local properties (e.g. communities, individual roles, structural bottlenecks and key players). All these aspects emerge from the global self-organization of all the interacting microscopic agents from simple and local interactions, naturally modeled as a time-dependent multidimensional graph (multiplex) obtained by experimental data from different sources like mail exchange datasets, organizational charts, and ad hoc surveys.

Particle Physics

Navigating the Hidden Sector: Designing the SHiP Experiment at CERN

Oliver Lantwin

Blackett Laboratory, Imperial College of Science, Technology & Medicine, London

Particle physics is stuck at an impasse: We have found nothing but the Higgs, and Supersymmetry (SUSY) is nowhere to be found. But the neutrino masses, dark matter and the fact matter overcame anti-matter to create the universe, prove that there has to be new fundamental physics, and that there have to be new particles, somewhere. But they have not been found at the Large Hadron Collider (LHC), nor has anything been seen by direct detection experiments for dark matter nor by precision tests of the standard model (SM). And without an energy scale to target the justification for any new collider is weak. So where else can we look? The Search for Hidden Particle (SHiP), is a proposed experiment to study a wide range of models invisible to our current experiments. To test these models with super-weakly interacting particles we need to solve an experimental contradiction: We need to achieve an extremely low background environment, while working at extremely high intensities. How we can overcome this experimental challenge and is the main topic of this poster.

Scintillating Bolometer Monte Carlo for Rare Particle Event Searches

Nicholas Deporzio
Northeastern University

This study uses the Geant4 physics simulation toolkit to characterize various scintillating bolometer constructions for potential experimental commissioning. Emphasis is placed on detector sensitivity to neutrinoless double-beta decay. Constructions minimally include a scintillating source material for the decay and an absorber material. Tellurium, Selenium, Germanium and other candidate isotopes are studied as source materials. Various background discrimination techniques are analyzed including reflective housings and anti-reflective coatings upon the source material. Different geometric optimizations are considered. Ability to discriminate incident alpha and beta radiation, as well as photon detection efficiency for each construction is presented.

$\Lambda_b \to J/\psi\phi\Lambda$ decay and search for the exotic hadrons

Júlia Tena Vidal
Universitat de Barcelona

We study the weak decay of the Λ_b into $J/\psi\phi\Lambda$ states and the possibility of exotic hadrons production in the final state interaction of $J/\psi\Lambda$ and $J/\psi\phi$ hadrons. The elementary weak transition at the quark level proceeds via the creation of a J/ψ meson and an excited sud system with $I = 0$, which upon hadronization leads to $\phi\Lambda$ and $\bar{K}N$ pairs. These pairs undergo final state interaction in coupled channels and end up as

an observed $\phi\Lambda$ pair. The hidden-charm pentaquark $Pc(4450)$ observed recently by the LHCb collaboration may be of molecular nature, as advocated by some unitary approaches that also predict pentaquark partners in the strangeness $S = -1$ sector. This strange hidden charm pentaquark can be produced via $\psi\Lambda$ final state interaction in our reaction and, as we shall see, such a state could be seen in $\Lambda_b \to J/\psi\phi\Lambda$ decay as a peak in the $M_{J/\psi\Lambda}$ invariant mass distribution. On the other hand, studying the Λ_b decay as a function of $J/\psi\phi$ invariant mass, $M_{J/\psi\Lambda}$, one can also observe the peaks corresponding to $X(4140)$ and $X(4274)$ exotic hadrons discovered by CDF and recently reconfirmed in the B decay at LHCb.

Analysis of $t\bar{t}$ background production in $H \to W^+W^- \to l^+l^-\nu\bar{\nu}$ processes in the CMS experiment at LHC

Rudy Ceccarelli
Universita degli Studi di Firenze

The discovery of a new boson, compatible with the Higgs boson expected by the Standard Model, has been announced by CMS and ATLAS collaborations in 2012. After the discovery, the properties of this particle have been studied in various decay and production channels, to verify the agreement with the theory. From 2015 the energy of proton-proton collisions at LHC has been increased to 13 TeV, so the higher statistics have permitted a deeper study of the Higgs boson. The study made by CMS in the decay channel is one of those activities. One of the most significant backgrounds of this channel is the $t\bar{t}$ production, characterized by the presence of quark b in the final state: $t\bar{t} \to W^+W^-b\bar{b}$. This work is about the study of b-tag procedures, that is the algorithms that can distinguish the jet produced form quark b from those produced by lighter quarks or gluons.

Solar Neutrino Oscillations

Valentina Biancacci
University of Trieste

Today we know the neutrino is an elementary particle without charge, with spin 1/2, and it has very small but finite mass. Neutrinos interact only via weak interactions and because of this they can be detected only with considerable difficulty. They come in three flavors: electron neutrinos (ν_e), muon neutrinos (ν_μ), and tau neutrinos (ν_τ), associated with the electron, muon, and tau, respectively. The Standard Model of particle physics (it explains the nature laws with a finite number of elementary particles and interactions) had assumed that neutrinos are massless and have a definite flavor. However, if neutrinos had mass, they could change flavor, or oscillate between flavors. This neutrino oscillation was the solution of the Solar Neutrino Problem. It consists in a discrepancy between measurements of the number of solar neutrinos flowing through the Earth and the real number of neutrinos produced by the Sun. The theoretical models of the solar interior predicts that the Sun should emit only electron neutrinos as they are produced by H-H fusion. The measured rate of electron neutrino flux is much smaller than the expected rate and it was explained by neutrino mixing. The neutrino flavour states ν_e, ν_μ, and ν_τ are linear combination of three mass states ν_1, ν_1, ν_1. As a neutrino propagates in time, the phases of the three mass states become different due to the slight differences in the neutrino masses. A different mixture of mass states corresponds to a different mixture of flavor states.

Physics Education

Physics Brawl, Online Physics Brawl and its Influence on the Physics Education

Daniel Dupkala
Charles University

This contribution presents competitions in solving physics problems organized by students of physics at Charles University. Physics Brawl is an international team competition for high school students in solving physics problems. The teams consist of up to five high school students or sometimes even younger gifted pupils. The goal is to solve as many problems as possible in time period of three hours. At the beginning, the team gets 7 problems. For each one solved, the team gets a new one. The Online Physics Brawls is almost identical competition, only difference is the online form. The age of contestants influences coverage of physics topics used for tasks and the their difficulty. The best teams solve in average 40 of more than 50 originally created problems. Mechanics covers almost 50 percent of all problems as it is the main topic in high school physics. Remaining problems are mostly from fields of electrostatics, optics, quantum and relativistic physics. The difficulty of task is raised by every new assignment and some of the last problems even cover the basics of college physics. Goal of this presentation is to show the contribution of competitions to the education of Physics, its improvement and popularization.

Quantum Physics and Technology

Basic Circuits of a Quantum Optics Network

Marco Canteri

University of Trento

The poster will present some basic circuits of a quantum optics network. Some configurations of waveguides and microresonators, where non linear optical effects occur, can be used as a source of energy-time entangled photons. Due to the low decoherence effects to which photons are subjected, these circuits have emerged as a leading approach to quantum information processing.

Ultrafast Dynamics in a Quantum Fluid Environment

Sascha Ranftl

University of Technology, Graz

Based upon the works of Ahmed Zewail (Nobel Prize 1999), the field of femtochemistry is nowadays an established field of science, studying ultrafast dynamics in molecules and reactions that take place within femtoseconds. The development of ultra-short laser pulses enabled the direct observation of molecular processes, e.g. photodissociation. Apart from femtochemistry, cold droplets of noble gases provide a micro-solvation environment for atoms and molecules, bridging from gas phase to liquid state. The goal of our experiment is to observe ultrafast dynamics not in molecules, but in doped droplets. On this poster I will present measurements on ultracold superfluid helium nano-droplets (0.37 K) doped with single indium atoms studied with a femtosecond pumpprobe setup and photo-electron time-of-flight spectroscopy

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Open quantum systems dynamics and measurement process

Guido Giachetti

Unversità degli studi di Firenze

Quantum mechanics require a postulate that describe the process of measurement (interaction with a macroscopic device) through a postulate that introduce ad hoc interaction and breaks the deterministic structure of the theory. Our aim is to mend this sharp break between macroscopic and microscopic world by providing a quantum description of the measurement process. In our work the dynamical interaction between the system and the measure- ment device, regarded as quantum object, is described by an effective hamiltonian: we shown that, in some particular settings, the macroscopic character of the measurement device lead to a decoherence process, essential condition to connect the outcome of the device to the state of the system, and allow the whole measurement process. In particular we used two different ideal measurement devices: one made up of a macroscopic number of a quantum two level sub-devices, and one composed by a single spin s system, in the limit of large s.

Bell's inequality

Alessandra Beni
Università degli Studi di Firenze

The formalization of Quantum Mechanics challenges some hypothesis considered fundamental in classical physic. The idea that a system could be simultaneously in many states is in contrast with our common sense. Einstein supported the idea that the probabilistic nature of measurement processes arises from an incompleteness of our description. This idea was considered useful to recognize Quantum Mechanics as a classical theory, although it was incomplete. The Bell's Theorem's demonstration made possible to verify experimentally if this idea could correspond to the reality or not: a violation of Bell's inequality excludes the possibility of Quantum Mechanics to be a classical theory. In my work I gave an extremely general demonstration of Bell's Theorem, based on properties of probability distribution. I also showed how it is possible to verify a violation of Bell's inequality, making local measurements of three spin components on two electrons in a singlet state, that were sent to two different apparatus. This is experimentally very hard to realize. For this reason I also gave a description of the logical scheme of a new class of thought-experiment.

Theoretical Physics

Minimal configuration in simplical quantumgravity with toroidal topology

Dániel Németh

Eötvös Loránd Science University

Numerical methods are playing an important role in the modern time's science, without them many approaches and results would be unreachable. To understand the structure and behaviour of the lattice-based systems (like CDT) one can use random walks via Monte Carlo simulations and measure some reasonable observables with the help of it. The recent research in CDT has shown that the choice of topology of the spacetime matters, and under toroidal condition we found an interesting behaviour of the system. After letting the system shrink, instead of reaching the minimal triangulation surprisingly it became smaller. This small system still keeps the attributes of the toroidal condition.

Semiclassical descritpion of the triaxial rigid rotor

Robert Poenaru
University of Bucharest

A triaxial rotor Hamiltonian is treated by a time-dependent variational principle, using a coherent state as a trial function. The critical points of the constant energy surface depend on the ordering relations satisfied by the three moments of inertia. All three orderings are considered and to each of them a specific wobbling frequency is derived. The transition between two distinct phases is discussed in terms of a cranking Hamiltonian. Four distinct pairs of complex canonical phase-space coordinates are pointed out. Each of them yields, after quantization, a distinct boson expansion for the angular-momentum components. The separation of the potential energy is treated for one of the four phase-space bases. One of the semiclassical descriptions is used for the yrast state energies of 158Er and an excellent agreement with experimental data is obtained up to very high angular momentum.

Constructive gravity in a nutshell

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Since the 1970s it is clear that the laws of gravity can be derived merely by enforcing that the causality of geometry – the gravitational field – has to coincide with the causality of all matter fields. Otherwise it would be impossible to consistently describe measurements in a common, predictive setup. In recent years it was possible to extend this to arbitrary geometries. The resulting system of partial linear differential equations, the gravitational construction equations, determine the

coefficients of the gravitational Lagrangian as their solution. Recently, these equations have been used to construct a perturbative solution beyond general relativity, allowing for the phenomenological effect of birefringence of light in vacuum. We will present some of the effects that arise in this setting and possible influence on experimental measurements.

The A-square problem and its relevance in the Dicke superradiance

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The Dicke model is the simpliest model describing an ensemble of N two-level atoms, in an optical cavity, interacting with a near resonant mode of the electromagnetic field. One of the most interesting results regarding this model is that for a sufficiently large value of the coupling constant between the atoms and the field, the system undergoes a second-order phase transition. Tuning the temperature below a certain critical temperature T_c the system converts from a normal phase, in which the intensity of the spontaneous emission of radiation is proportional to N, to a "superradiant" phase in which the system emits spontaneous coherent radiation with intensity proportional to N^2. This phase transition is called superradiant phase transition (SPT). But if the $\mathbf{A}^2$ terms are included in the Hamiltonian of the system, no-go theorems are proved that forbid the SPT, hence the SPT appears as an interesting artifact arising solely from the absence of the $\mathbf{A}^2$ terms from Dicke Hamiltonian. In my poster I'm going to show how the problem of correctly deriving the Dicke Hamiltonian and justifying the existence of the SPT have been faced in literature.

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