BOOK OF ABSTRACTS

WDS 2024

Book of Abstracts

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by presenting authors in each section.

Observational Analysis of Star-forming Dwarf Galaxies

Adamcova B., Svoboda J., Kouroumpatzakis K., and Kyritsis E.

Abstract. Most galaxies in the early Universe were compact dwarf galaxies with intense star-formation. The ionising radiation from these galaxies is considered to be the main mechanism for the reionisation of the Universe. Before JWST, these high-z galaxies could not be observed directly and their local analogues were studied in detail instead. The properties of these dwarf galaxies have not been fully explained, mainly the occasional presence of AGNs and their consequence for cosmic reionisation.

A Novel Solution for Maxwell Equations via Symmetry Operators Acting on a Test Field Solution

Arias C. and Kubiznak D.

Abstract. The principal Killing–Yano tensor encodes a hidden symmetry of rotating black hole spacetimes, where it ensures complete integrability of geodesic motion and separability of various test field equations. In particular, as shown in recent studies, the principal tensor can be used as a building block for constructing symmetry operators for scalar, vector, and tensor perturbations. Focusing on Maxwell perturbations, we apply the corresponding symmetry operator on a test field solution describing a rotating black hole immersed in an asymptotically uniform magnetic field tilted with respect to the hole's axis of rotation. We show that in this way we can generate a novel solution of Maxwell equations whose relevance for astrophysical applications is subject to current investigations.

X-ray Polarimetric Analysis of the HMXB Cygnus X-1

Brigitte M.

Abstract. This talk presents the Imaging X-ray Polarimetry Explorer (IXPE) observations of the High-Mass X-ray Binary (HMXB) Cygnus X-1, showing a high polarisation degree and a polarisation angle aligned with the black hole axis. According to Chandrasekhar–Sobolev solutions, the thermal emission should be polarised perpendicularly to the disc symmetry axis. To compare the theory with the observations, we conducted a spectro-polarimetry analysis of the well-known source.

Effective Field Theory of Large Scale Structure

***Farakou D.* and Skordis C.**

Abstract. Effective Field Theory of Large Scale Structure (EFTofLSS) is an analytical way of studying the mild nonlinear regime of structure formation in our universe. I will discuss the impact of EFTofLSS on the Cosmic Microwave Background (CMB) radiation, focusing on the corrections to CMB lensing and the importance of addressing some of the current cosmological tensions with EFTofLSS. I will briefly discuss our ongoing efforts to create an emulator for fast calculation of the EFTofLSS power spectrum.

Multi-Black Hole Gravitational Field

***Klimesova E.* and Zofka M.**

Abstract. We discuss a system of three extremally charged black holes moving in their own gravitational field. We perturb the exact Majumdar–Papapetrou spacetime in velocities, as proposed by Ferrell and Eardley for n black holes. This has been done for two holes, we extend it by adding a third one. We compare the motion of the third black hole to that of a test particle in the field of two holes. What remains is the self-force due to the third black hole acting on itself.

Particles, Strings, and Black Holes in 2+1 AdS

***Lukes P.* and Krtous P.**

Abstract. Many works have already been written both about BTZ black hole (a black hole in 2+1 AdS) and about C-metric (accelerated spacetime, mainly AdS, in general dimension). This work reviews combinations thereof, shifts the focus from metric computations to geometry and describes novel spacetimes where one- and two-dimensional defects are interpreted as particles, strings or struts and black holes.

Beyond Color-Kinematic Duality and the Classical Double Copy

***Martinez-Gomez A.* and Witzany V.**

Abstract. The double copy is a duality linking a gauge field theory and gravity, which initially focused on scattering amplitudes based on the so-called Color-Kinematic duality. We aim to uncover a deeper mechanism behind this duality and apply the findings to gravitational wave science. To do so, we study the classical limit of some specific Yang–Mills theories with their gravitational counterparts, given by the double copy. In this talk, I will summarize some incarnations of the double copy and present our initial efforts to better understand the scope of this duality and its possible applications.

Accelerated RegMax Black Holes

Hale T., Kubiznak D., Mensiková J., Mann R.B., and Yang J.

Abstract. Recently, a new theory of non-linear electrodynamics coupled to gravity (RegMax) was discovered and its thermodynamics and other properites were studied. In this talk, we take a step further and consider accelerated RegMax black holes described by C metric. We calculate important thermodynamic quantities (mass, charge, temperature etc.) and also point out some challenges which we encountered along the way.

Thermodynamic Transformations in Far-from-equilibrium Systems

Mlada K.

Abstract. Within the framework of discrete Markov jump processes, we investigate adiabatic transitions between stationary states. What can be explored? We examine potential approaches, including describing stationary states by theoretical-graph methods, using adiabatic expansion as a way to calculate observable quantities like heat capacity, and deducing variational principles from the fluctuation theory. We highlight the similarities and differences with equilibrium thermodynamics on the one hand and variational principles from the Onsager–Machlup Lagrangian on the other.

Analytic Solutions in Open String Field Theory

Morozova A.

Abstract. We study the extended KBc algebra, which is used in the construction of new algebraic solutions in the Open Bosonic String Field Theory. The constructed solutions depend on string fields and holomorphic functions. We compute their energy using the gauge invariant observables (Ellwood's invariant); to later compare with the computation resulting from the kinetic term approach.

Multiwavelength Emission from Markarian 421

Muthyala S., Araudo A., and Jurysek J.

Abstract. Markarian 421 (Mrk 421) is one of the closest and brightest, extragalactic, high-frequency peaked BL Lacertae (HBL) at a redshift of $z = 0.031$. To find the phenomenon behind the broadband emission spectrum of this Tev blazar, it is necessary to study the multiwavelength observations and correlations on timescales of years. Using data available in the literature and new observations from the SST-1M gamma-ray telescopes in Ondrejov we model the radio to gamma-ray emission from Mrk 421.

Jamming of Active Particles in Quasi-1D Geometries

Pajger S.

Abstract. We study the behavior of active particles in 1D simple exclusion process-like models, where we have a ring discretized into sites that particles can jump between, and on a single site, there can be at most two particles. We investigate in detail the jamming transition, i.e., when a situation occurs, in which most of the particles are in one cluster and cannot move, and how such a cluster behaves. In particular, we study a case with a broken spatial symmetry, where in one direction there are dead-ends appended at each site, in which active particles can be trapped. We show that the jamming transition is of first-order type, characterized by long-lived metastable states. Broken spatial symmetry leads to a non-zero ratchet current, which in turn competes with the jamming transition.

Reconstruction of the Depth of Maximum of Air-shower Profiles at the Pierre Auger Observatory Using Cherenkov Technique

Panja S.

Abstract. I am studying the reconstruction of the depth of maximum profiles of air showers using the Pierre Auger Observatory data. Specifically, the Cherenkov technique is used for this study. The measured average values and the fluctuations will then be used in this study to make inferences on the cosmic ray mass compositions, mainly in the transition region from galactic cosmic rays to extra galactic cosmic rays. This region is not very well understood mainly because data from different observatories disagree with each other. My aim is to add measurements with Pierre Auger Observatory to clarify these discrepancies.

Early Universe with Anisotropy

Racko D.

Abstract. General relativistic solid matter can be described through a triplet of fields with global Euclidean symmetry. In our work, we assume the breaking of the SO(3) rotational part of the Euclidean symmetry group to SO(2), two-dimensional rotations, which is then related to the anisotropy in the expansion of the universe. We consider a two-component model of the early universe in which ordinary perfect fluid dominates the dynamics of its expansion, however, we consider a small anisotropy in the expansion caused by fields with aforementioned global symmetries. We choose the x spatial coordinate for the direction in which isotropy is violated. We investigate the evolution of such anisotropy under the assumption that the era with anisotropic expansion starts after cosmic inflation and ends at the energy scale of 100 TeV.

Ensemble Holography and 3d Euclidean Wormholes

Rossi P.

Abstract. I will talk about the idea of "ensemble holography," the duality between a (d+1)-dimensional theory of (quantum) gravity and an ensemble average of d-dimensional Conformal Field Theories living at the boundary of spacetime. Focusing on the case of d=2, I will briefly review the motivations that led to this paradigm and discuss a class of exotic toy models that might realize such a duality. Euclidean wormholes should capture the variance of the ensemble distribution of boundary CFTs.

Carrollian Gravitational Theories

Tadros P. and Kolar I.

Abstract. This talk summarizes the results on the electric and magnetic Carroll limits of quadratic gravity and presents the resulting classification of non-equivalent Carrollian gravity theories depending on the parameters of the theory. The procedure is then extended to the Carroll and Galilei expansions for a generic (finite order) gravitational theory. The algorithm developed proves to be computationally simpler than the conventional expansion and truncation method, enabling more efficient derivation of equations of motion. Additionally, some applications to black holes and thermodynamics will be discussed.

Black Holes in AeSt Theory

Skordis C. and Vokrouhlicky D.

Abstract. The recently proposed AeST theory is an extension of General relativity successful at reproducing MOND-like regimes as well as near LambdaCDM cosmology, CMB power spectrum, and correct lensing. The vacuum equations for this theory in its strong-field regime are solved in the most general spherically symmetric configuration. General classes of solutions are found; some of which are interpreted as viable physical Black hole solutions.

F-2 PHYSICS OF PLASMA AND IONIZED MEDIA

Measurements of Plasma Density using Complex Interferometry in Laser–Matter Interaction

***Agarwal S.**, Singh S., Krupka M., Devi P., Krasa J., Burian T., Dudzak R., Dostal J.,Wild J., and Juha L.*

Abstract. High-intensity laser matter-generated plasmas show complex dynamics of charged particles in strong electromagnetic fields. Plasma density measurements are carried out using complex interferometry setup at Prague Asterix Laser System (PALS). This article presents a method of phase reconstruction to determine the time evolution of electron density distribution using 3-frame complex interferometry. These findings provide insights into density modulation and instabilities in laser-produced plasma.

Automatic Region Identification in Spacecraft Data

***Aghabozorgi Nafchi M.**, Pi G., Tsai T.-S., and Nemec F.*

Abstract. We use supervised machine learning methods to develop an automatic routine to classify distinct regions of near-Earth space (solar wind, foreshock, magnetosheath, and magnetosphere). Human-labeled dayside magnetic field and plasma measurements from the THEMIS B spacecraft, spanning from 2008 to 2010 (340 days in total), are used for this purpose. Two different methods are used and compared: the random forest classifier and the neural network. The optimization of these methods is thoroughly discussed, and their high overall accuracy is demonstrated. The results will be used for further studies, particularly in analyzing the locations of boundaries between the respective regions (bow shock, magnetopause).

Design and Modelling of the High-temperature High-vacuum Flanges

Barton P., Patocka K., and Prevratil J.

Abstract. Tokamak COMPASS-U will feature the heated vacuum reaction vessel (up to 500 °C), allowing us to study the plasma fueling in great detail. This, unfortunately, means that the usage of ordinary vacuum seals for the connection of diagnostics to the vacuum vessel is not possible. This contribution shows the development and optimization of the flanges, which will be able to house the so-called resilient metal seals, designed to withstand high temperatures while ensuring a low leak rate into the vacuum vessel.

Investigating Plasma Depletion Events in the Martian Ionosphere: Insights from MAVEN and Mars Express

Basuvaraj P., Nemec F., Fowler C.M., Regoli L., Nemecek Z., and Safrankova J.

Abstract. The MAVEN spacecraft, orbiting Mars since September 2014, has detected about 1,000 plasma depletion events (PDEs) in the Martian ionosphere. PDEs are regions of significantly reduced plasma density, whose formation mechanism, evolution, and spatial extent remain unclear. We analyze simultaneous electron density measurements by the MARSIS instrument on the Mars Express spacecraft with the aim of looking for possible conjugate events and estimating the spatiotemporal scales of the events. This is accompanied by the investigation of the recurrent PDE detections using MAVEN. Our analysis suggests that PDEs can extend up to 800 km horizontally and persist for at least 4 hours.

Filter Stack Spectrometer in Laser–Plasma

Devi P., Singh S., Agarwal S., Krupka M., Dudzak R., Svandrlik L., Krasa J., and Juha L.

Abstract. In laser–plasma interaction experiments, a large amount of laser energy is converted into hot electrons and bremsstrahlung radiation. Bremsstrahlung spectrum is crucial for understanding hot dense plasma. At the PALS facility, an optimized filter stack spectrometer with aluminium, copper, and lead slabs with imaging plates use to measure this spectrum. FLUKA simulations and unfolding algorithms analyses for better understanding the laser–plasma interactions.

Power Line Harmonic Radiation Observed by the Kannuslehto Station

Drastichova K., Nemec F., and Manninen J.

Abstract. We investigate power line harmonic radiation (PLHR) from electric power networks at harmonics of the base system frequency (50 Hz in Europe). Data from the Kannuslehto station in northern Finland and the burst mode data from the low-altitude DEMETER spacecraft are used. The wave intensities are analyzed with respect to the local time and geomagnetic activity. Periods of sudden magnetic changes identified in the flux-gate magnetometer data near Kannuslehto are investigated in more detail.

Magnetopause Motion Speed: A New Hypothesis Through Ion Speed Analysis

Ghosh M., Pi G., Safrankova J., and Nemecek Z.

Abstract. The magnetopause is the critical boundary between the shocked solar wind from the sun and the magnetic field from the magnetosphere. Once the upstream solar wind conditions change, the magnetopause moves to a new position and changes its shape accordingly. The observation shows that the magnetopause motion is highly periodic, which leads to multiple crossings. Previous studies usually calculate the magnetopause moving speed from parameters of two crossings that were close in location and time. However, such events are relatively rare. We propose a new hypothesis by applying ion speed in the magnetopause layers to estimate the speed of magnetopause motion. Magnetopause is often considered a thin, thick-less surface. Still, the observation data shows magnetopause as a layer around hundreds of km thick. As a boundary that plasma cannot pass through, the ion speed in the magnetopause could be related to the magnetopause speed. Our study aims to check whether this hypothesis is correct by using numerous magnetopause crossings recorded by the THEMIS mission. The magnetopause speed calculated using the traditional method will be compared with the results estimated using the new process.

Deuteration and Nuclear-Spin Effects with Ammonia Chemistry in Ion Trap Experiment

***Hernandez Alvarez O.E.*, Rednyk S., Roučka Š., Dohnal P., Plašil R., and Glosík J.**

Abstract. Our research delves into the fundamental processes of ammonia chemistry in space, with a particular focus on the effects of deuteration and nuclear spin states. By using a cryogenic 22-pole ion trap, we investigate the kinetic interactions among NH_3 and its isotopologues, specifically measuring reaction rate coefficients for D_3^+ and NH_3 reactions under interstellar conditions. These measurements aim to bridge crucial gaps in current astrochemical models by providing precise data on ammonia's formation and behavior in the cosmos.

Dust Impact-Like Events Observed by the Demeter Spacecraft

***Ijaz S.*, Vaverka J., Safrankova J., and Nemecek Z.**

Abstract. The electric field instruments are capable of detecting transient pulses in the measured electric field caused by dust impacts on a spacecraft's body. This study presents the first analysis of dust impact-like signals detected by the electric field instrument (ICE) onboard the DEMETER spacecraft. We utilize data from the French microsatellite DEMETER, launched in June 2004 into a nearly Sun-synchronous polar orbit at a low altitude of approximately 710 km. We discuss the differences between the day and night side observations of the dust impact-like events, their spatial variations, and possible sources of signal misinterpretation.

Development of Magnetic Field Diagnostics for Fusion Reactors

Ivanek M.*, *Duran I., Entler S., Torres A., Sladek P., Simonovsky M., Reboun J., and Turjanica P.

Abstract. Magnetic diagnostics play a crucial role in determining key parameters of tokamak plasmas, such as plasma position and shape. Traditional methods for measuring magnetic fields during tokamak discharges rely on inductive sensors, such as pick-up coils. While these sensors are adequate for tokamaks with relatively short pulses and limited radiation levels, fusion reactors with long pulse lengths and high radiation environments require the use of steady-state magnetic field sensors, such as Hall sensors. In this presentation, the principles behind magnetic field measurement in the fusion plasma environment will be reviewed. The performance and drawbacks of pick-up coils will be described, and advancements in Hall sensor development for fusion reactors will be outlined. The challenges associated with the utilisation of Hall sensors in such environments will be addressed, including the necessary techniques such as synchronous detection and current spinning. Finally, the potential for data fusion of inductive and Hall sensors using the Kalman filter algorithm to enhance measurement accuracy will be discussed.

Peak Intensity of 5×10^{18} W/cm^2 Observed in Laser Beam Focus at Prague Asterix Laser System

Jelinek S.*, *Dudzak R., Juha L., and Chalupsky J.

Abstract. Intensity distribution of a focused laser beam is crucial in evaluation of laser–matter interactions phenomena. The authors studied the laser beam caustic at Prague Asterix Laser System by capturing magnified images of in-focus and around-focus positions and applying a Phase Recovery algorithm. Measured peak intensity of 5×10^{18} W/cm^2 is two orders of magnitude higher than previously expected. Reasons for the discrepancy are discussed, as well as relations to a selection of previous experiments.

Analysis of Sputtered Species Transport in High Power Impulse Magnetron Sputtering (HiPIMS) Discharge by Means of Magnetized QCM Probe

Kapran A., Ballage C., Hubicka Z., and Minea T.

Abstract. The optimization process of HiPIMS discharge is challenging due to the complexity associated with the transport of the sputtered species, ionized or neutrals. The limited knowledge available on the spatial distribution of these species when operating a HiPIMS discharge makes the quantitative prediction of any deposition feature particularly difficult. We investigated the influence of experimentally controllable quantities, such as gas pressure and target current density, on the transport of sputtered titanium in non-reactive (argon) HiPIMS, namely on the behavior of metal atoms and metal ion fluxes intercepting the substrate. Systematic quantitative measurements were carried out using a modified quartz crystal balance (QCM) equipped with an electron magnetic filter (M-QCM). The wide range of investigated parameters gives precious hints to predict and optimize the flux of sputtered species based on complete mapping of the IFF of sputtered particles for different magnetic field configurations. In particular, the results can be used to define strategic substrate positions during deposition processes, depending on the desired objectives.

Recombination of HCO^+ Ions with Electrons at 170 K

Kassayova M., Dohnal P., Slezak P., Uvarova L., Rednyk S., Roucka S., Plasil R., and Glosik J.

Abstract. The formyl ion, HCO^+, is a pivotal molecule in the interstellar medium, first noticed over 50 years ago, labeled as “X-ogen,” prior to its laboratory identification. Understanding its recombination processes, particularly in low-temperature environments, is crucial for unraveling fundamental chemical kinetics both in astrophysically relevant environments and laboratory simulations. A stationary afterglow apparatus equipped with microwave diagnostics technique and Cavity Ring-Down Spectroscopy was used at 170 K to determine the recombination rate coefficient for recombination of HCO^+ ions with electrons. The first results of the experiment will be shown at the conference.

Post-Return Stroke VHF Electromagnetic Activity in North-Western Mediterranean CG Flashes

***Kolinska A.*, Kolmasova I., Defer E., and Santolik O.**

Abstract. Using data from the SLAVIA magnetic loop sensor and the SAETTA lightning mapping array, we investigate electromagnetic signatures of 69 negative (–CG) and 29 positive (+CG) cloud-to-ground flashes. After the first return strokes, we found distinct behavior patterns depending on the flash polarity — strong VHF radiation, lasting for tens to hundreds of milliseconds, in all +CG flashes and a nearly immediate decrease of VHF radiation in 62 –CG flashes.

Implementation of Melnikov Integral Method for Tokamak Magnetic Footprints Characterization

***Kripner L.* and Cahyna P.**

Abstract. In this contribution, we investigate magnetic footprints in tokamak plasmas with a 3D magnetic field. Conventionally mapped using field line tracing, we present the faster Melnikov integral method and its practical implementation. Various forms of the method are compared, including its second-order approximation and inclusion of the x-point distortion effect.

Heating of X-ray Optics by Synchrotron and Free-electron Laser Radiation: A Role of Elemental Composition

***Kuglerova Z.*, Burian T., Bulicka J., Vagovic P., Ronch M., and Juha L.**

Abstract. Synchrotrons and free-electron lasers represent ultrabright sources of short-wavelength radiation. Intense x-ray pulses generated at a high repetition rate can cause severe damage to optical elements used for beam guiding and focusing. Numerous thermal and non-thermal processes can be responsible for irreversible changes of optical elements and/or materials exposed to intense X-rays. NIR thermal camera was used for monitoring of a temperature on surfaces of selected optical elements heated by trains of ultra-short x-ray laser pulses at the European XFEL facility.

Spatially Resolved Ions Imaging at Room Temperature

Kumar V., Lausti N., and Hejduk M.

Abstract. We present a simple and cost-effective imaging setup consisting of relay lenses and an electron-multiplying CCD camera to efficiently detect ^{40}Ca atoms fluorescence during loading and $^{40}Ca^{+}$ ions during Doppler cooling. The setup provides a theoretical spatial resolution of 562 nm for ^{40}Ca and 529 nm for $^{40}Ca^{+}$ at a magnification of 10x. For optimization of the signal acquired by the camera, we identify various noise sources and present the optimal setting of operation parameters that suppress them.

Feasibility of 3D-printed Material for UHV and Microwave Electronics

Lausti N., Kumar V., and Hejduk M.

Abstract. We present studies about feasibility of 3D-printed materials for ultra-high vacuum (UHV) and microwave electronics. These properties could be useful in various applications, including ion and electron trapping. 3D-printing is an automatic way to manufacture equipment for them, even with complex shapes, which are difficult to produce in other ways. 3D-printed aluminium alloy, suitable for electronics due to its good conductivity, is compatible with UHV. Though surface roughness of the material disrupts its use in microwave electronics, this challenge can be solved by polishing. The results will help us to build a working electron–ion trap, but also contribute to development of 3D-printed equipment for other vacuum technology and electronics.

Dust Environment of Distant Comet C/2015 V1 (PanSTARRS) Beyond the Snowline

Lashkova A., Ivanova O., and Parimucha S.

Abstract. The compositional taxonomy of the small icy bodies allows for establishing a possible correlation between the physical properties of the distant dwellers and their orbital characteristics shedding light on the primordial physical conditions at the places of their formation. Studies of comets in their active phase can be especially informative. It is especially interesting to trace the activity evolution of the dynamic new comets moving into the inner Solar System for the first time and compare it with the activity of returning comets, which have had passages through the inner Solar System and as a result have their outermost layers disorientated and depleted of volatiles.

Lightning-Induced Electron Precipitation Events Observed by DEMETER

Linzmayer V., Nemec F., Santolik O., and Kolmasova I.

Abstract. Lightning-induced electron precipitation (LEP) events are important phenomena in the inner Earth's magnetosphere, where lightning strokes result in energetic electron loss from the radiation belts. We detect and analyze these events using the DEMETER satellite data. We develop a semi-automatic procedure to detect LEP events, detecting more than 600 events. These are systematically analyzed, revealing the energy spectrum of the precipitating electrons, and the global significance of the events.

Plasma Application Technology for Nuclear Power Plant Contamination Abatement

Mekki R.N., Hubicka. Z., and Tichy M.

Abstract. The objective is to provide an overview of cleaning power plants methodologies, with a particular focus on the cleaning of liquid metal divertors using plasma. Because one of the biggest challenges is the ability to compromise the fusion process and its efficiency, thus the big concern is the heat loss. Moreover, plasma-facing components based on liquid metals were proposed for use, especially in the divertor area, to circumvent challenges that occur for solid metal components, such as erosion lifetime, neutron embrittlement or transient overloading. According to the COMPASS project, the most successful alloy currently in use is tin and lithium. However, the use of the liquid metal divertor is not without consequences. It is inevitable that contamination will occur will inevitably lead to contamination and decontamination issues, which must be addressed. Some studies have been conducted on the components of the alloys used in nuclear power plants, including the liquid metal divertor. However, there is a lack of research on remediation strategies for contamination problems. Should tin be identified as a solution, it could be used directly, with further cleaning and treatment.

Statistical Analysis of Waves in the Solar Orbiter TDS-RPW Data

Micko J., Soucek J., Pisa D., and Santolik O.

Abstract. The data provided by TDS-RPW instrument aboard the Solar Orbiter spacecraft is analysed, in particular, Langmuir and ion acoustic waves detected by onboard algorithm. Basic properties of detected waves are recorded in the statistics dataset (STAT), while for some events, full waveform snapshots are recorded as triggered snapshots (TSWF). We attempt to identify waves in the STAT dataset which are also recorded as triggered snapshots to correct and improve the statistical dataset.

Applicability of the Branching Fraction Method Using Optical Emission Spectroscopy in a Non-segmented Cathode System at Low Pressure

Mishra H., Tichy M., and Kudrna P.

Abstract. A method is used to determine the densities of metastable and resonant species in low-temperature, low-pressure argon plasmas. This involves measuring the ratios of spectral lines corresponding to transitions from shared upper states to resonant or metastable lower states. Photon reabsorption affects these ratios, making them sensitive to the population densities of the lower states. We studied the impact of self-absorption on key neutral argon spectral lines, including one at 750 nm, which is commonly used in actinometry. By using escape factors, a set of nonlinear equations for the line ratios that are independent of the upper state densities are solved. These equations can be utilized for metastable and resonant state population densities using a least squares method without using the knowledge of the electron energy distribution.

Hybrid HiPIMS+ Cathodic Arc Ion Energy Distribution Function Measurement with Carbon Target

Naiko I., Cada M., Ostapenko A., Venkrbcova I., and Hubicka Z.

Abstract. A new deposition system based on combining HiPIMS and pulsed arc discharge in different modes has been developed. A planar magnetron with an unbalanced magnet and a pure carbon target was used as the HiPIMS source. The experiments were carried out at pressures of 1.4 Pa and 0.7 Pa in an argon environment. The measurements showed that the IEDF in HiPIMS mode has a longer C^+ population compared to the other modes. Also, in the hybrid modes, the C^{++} ion population was also observed to be prolonged.

A SIFT Study of Reactions of Positive and Negative Ions with Polyfluoroalkyl (PFAS) Molecules in Nitrogen

***Omezzine Gnioua M.*, Dryahina K., Swift S.J., and Spanel P.**

Abstract. Data are needed for SIFT-MS analyses of per- and polyfluoroalkyl substances (PFAS), which persist in the environment and human body and potentially lead to adverse health effects. The new generation SIFT-MS instrument Voice200 series improves reagent ion selection by adding negative ions OH^-, $O_2^{-\bullet}$, $O^{-\bullet}$, NO_2^-, and NO_3^- to the set of previously used H_3O^+, NO^+, and $O_2^{+\bullet}$ ions. Understanding the reactions of these ions with PFAS vapors is thus needed. Rate coefficients and product ion branching ratios were obtained for pentafluoropropionic acid, heptafluorobutyric acid, nonafluoro-1-hexanol, perfluoro-2-methyl-2-pentene, perfluorohexanoic acid, perfluoro(2-methyl-3-oxahexanoic) acid, tridecafluoro-1-octanol, and nonafluorobutane-1-sulfonic acid in dry and humid air introduced to SIFT-MS while all reagent ions were repeatedly injected in a sequence. The results indicate that the positive ion reaction products are affected by humidity; the negative reagent ions remain stable and could potentially be used for SIFT-MS analyses of PFAS in different products and indoor and outdoor environments.

Langmuir Probe Sheath Size and Comparison with Plasma Properties

***Palacky J.* and Roucka S.**

Abstract. A plasma sheath is formed when a plasma is surrounded by a surface at a potential different from the plasma potential, creating a shielding layer. While the behavior of the plasma sheath has been well understood for steady-state and simple surface geometries, it becomes more challenging to study in dynamic situations. One such dynamic event is a change in the probe potential, which requires the plasma sheath to adjust itself to the new conditions over a certain period of time known as the sheath transition time. This transition time is influenced by various factors including pressure, plasma composition, and temperature. In order to accurately investigate the dynamics of the sheath, it is crucial to correctly determine its size. To address this, we have developed a method that calculates the sheath size from the potential around the probe. To verify the validity of such method we decided to compare it with the velocity properties of the plasma particles around the probe.

Application of Atmospheric Cold Plasma to Pesticide Degradation

Pardo A., Klas M., and Matejcik S.

Abstract. According to WHO estimates, the global population is expected to increase by around 20 percent by 2050, requiring an increase in crop productivity, therefore the use of pesticides cannot be reduced despite their health risks, and they will continue to play a critical role in preventing crop losses. After applying pesticides to crops, some may be found in food due to their low solubility in water and long stability. Currently, one of the challenges is to develop technologies that eliminate pesticides without causing damage to the food. Cold plasma technology is a promising tool for pesticide removal because of its ability to degrade molecules through reactive species that compose the plasma. Evaluating the degradation of chlorpyrifos using Corona Discharge is the aim of this study taking into account its risk to human health and its repeated appearance in the last results obtained by The Multiannual National Control Program to monitor the pesticide residue carried out by the EFSA. The quantification and identification of degradation products were made by IMS and MS. The 3,5,6-trichloro-2-pyridinol was the main product of the degradation by Corona Discharge.

Statistical Study of ULF Fluctuations and Determination of Their Boundary

Salohub A., Safrankova J., Nemecek Z., and Pi G.

Abstract. The orientation of the Interplanetary Magnetic Field (IMF) plays a crucial role in the characteristics and propagation of foreshock waves. The angle of the IMF relative to the Earth's bow shock surface influences the spatial extent and distribution of these waves. In our study, we examined Ultra-Low Frequency (ULF) fluctuations of the IMF magnitude and components and plasma parameters over 10-minute intervals during the initial stages of the THEMIS mission. We focused on wave activity, including compressive and Alfvén-like fluctuations, as well as on the ion foreshock boundary dynamics. The preliminary findings indicate that Alfvén-like fluctuations are more pronounced at greater distances compared to compressive fluctuations that are observed close to the bow shock. Further analysis using the foreshock coordinate system allows us to differentiate the strong and weak ULF foreshock boundary locations for different IMF orientations, solar wind speed and Mach number.

Implementation of Microwave Diagnostics in a SA-CRDS Apparatus

***Slezak P.**, Dumitru S.-M., Kassayova M., Dohnal P., Roucka S., Rednyk S., Plasil R., and Glosik J.*

Abstract. We report on the implementation of microwave diagnostics into a stationary afterglow (SA) setup in a SA-CRDS apparatus. Calibration measurements were conducted in afterglow plasma ignited in helium or helium/argon mixtures, as well as in plasma dominated by HCO^+ ions. The microwave diagnostics, together with CRDS (Cavity Ring-Down Spectroscopy), enabled the measurement of both ion and electron number densities, enhancing the accuracy of recombination coefficient determination. Initial results indicate a successful implementation and good agreement between the measured ion and electron number densities. This approach provides new opportunities for a more detailed analysis of chemical processes in plasma and has broad applications in atmospheric chemistry and plasma physics.

Electron Density Measurements in Low-pressure Hollow Cathode Plasma Jet System Using Cutoff Probe

***Tuharin K.**, Mishra H., Turek Z., Tichy M., and Kudrna P.*

Abstract. Electron density plays a pivotal role in characterizing processing plasma, exerting a significant influence on factors like deposition rate and uniformity. We present a study of electron density obtained in a low-temperature plasma by the cutoff probe and compare the results with data from both the hairpin and the Langmuir probes. The measurements were conducted in a DC discharge generated by an iron hollow cathode [1] under identical experimental conditions. This comparative analysis provides insight into the reliability and consistency of electron density measurements across different probe types Measurements of electron density are performed in a mixture of argon and oxygen at a low pressure of 5 Pa, in dependence on the discharge current and Ar:O_2 mixture ratio. Keywords: Cutoff probe, Hairpin probe, Langmuir probe, DC discharge References [1] H. Mishra, K. Tuharin, Z. Turek, M. Tichý, P. Kudrna, "Electron density measurements in low-pressure plasmas using cutoff probes and comparison with hairpin and Langmuir probes," Phys. Plasmas 4, 043510 1-9 (2024).

Analysis of Curling Probe in Low-pressure Hot Tungsten Cathode System

Turek Z., Mishra H., Kudrna P., and Tichy M.

Abstract. In 2011 Japan group introduced new RF probe called curling probe for electron density measurement. We are developing our own version of curling probe and calibrating it using dielectric materials with known electric permittivity. We are comparing results from CP measurement with data obtained from Langmuir probe.

Collisional Deexcitation and Radiative Lifetime of Vibrationally Excited HCO^+ and HOC^+ Ions

Uvarova L., Jimenez-Redondo M., Dohnal P., Kassayova M., Caselli P., and Jusko P.

Abstract. The 22 pole rf cryogenic trap setup CCIT and Cavity Ring Down Apparatus (CRDS) were used to study the radiative lifetime and the collisional deexcitation of vibrationally excited HCO^+ and HOC^+ ions. Laser Induced Reactions (LIR) HCO^+ with CO_2 and HOC^+ with Ar were used in order to determine the spectral properties of studied ions. P(1)–P(8) lines of HCO^+ ions and R(1)–R(4), R(8)–R(11) lines of HOC^+ ions that correspond to the first overtone transitions were measured during the presented study.

Solar Wind Structures as a Source of the Magnetosheath Transient Phenomena

Xirogiannopoulou N., Goncharov O., Safrankova J., and Nemecek Z.

Abstract. Plasma structures with enhanced dynamic pressure, density or speed are often observed in Earth's magnetosheath. These structures, known as jets and fast plasmoids, can be registered in the magnetosheath, downstream of both the quasi-perpendicular and quasi-parallel bow shocks Previous studies established that foreshock structures can be a source of the jets (Raptis et al., 2022). Xirogiannopoulou et al. (2023) found that the subsolar foreshock contains several types of structures with enhanced density or/and magnetic field magnitude, like plasmoids, SLAMS and mixed structures. Following the results of Xirogiannopoulou et al. (2023) and Goncharov et al., (2020), we compare our MMS measurements with THEMIS observations. Based on our comparative analysis, we discuss features of the magnetosheath transients, their relation to the foreshock, and impact on the magnetopause.

Preparation and Characterization of UGe_2 Thin Films

***Alex S.G.*, Zorilo I., Horak L., Andreev A.V., and Tereshina-Chitrova E.A.**

Abstract. The coexistence of superconductivity (SC) and ferromagnetism (FM) in UGe2 highlights its potential for novel quantum states and applications. UGe2 has an orthorhombic ZrGa2 structure with a = 4.036 Å, b = 14.9 Å, and c = 4.116 Å. The Curie temperature (TC) in bulk UGe2 decreases under pressure from 52 K, vanishing at ≈1.6 GPa, while SC is induced at 1.1 GPa within the FM state. We prepare UGe_2 thin films by DC sputtering to investigate the influence of microstructure on magnetism. Structure is studied using XRD, and magnetic and electrical resistivity properties are investigated. SC is not found in the films down to 0.35 K, and the decreased TC is due to structural defects. Anomalous paramagnetic behavior of bulk UGe_2 is even more pronounced in thin films, suggesting an anomalous lattice state, necessitating further studies. This work underscores the importance of thin-film studies for unconventional superconductors. We thank GACR, grant no. 22-19416S, and Vakuum Praha for the student Vakuum Praha Grant 2024.

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[2] D. Aoki et al., J. Phys. Soc. Jpn 88, 022001 (2019).
[3] G. Oomi et al., J. Phys.: Cond. Matt. 15, S2039 (2003).

Diffuse Scattering of Two-dimensional Ferroelectrics

***Flores Gonzales J.E.**, Antunes Correa C., Verhagen T., and Pasciak M.*

Abstract. Ferroelectric two-dimensional materials present technologically interesting properties such as polarization switching by in-plane interlayer sliding and enhanced capacitance due to almost no structural disruption at the surface. The compound under study grows as structure of stacked van der Waals layers. Interaction between layers promotes the creation of twins with a small twist angle, resulting in a moiré lattice. Preferred twist-angles between twins were identified by X-ray diffraction. This hints the presence of a short-range correlation (twisting is between adjacent layers) that shapes the stacking of layers. X-ray diffuse scattering is well suited for the study of short-range correlated systems since it is the fingerprint of such correlations. Crystals of the lead-based compound were studied with synchrotron X-rays at different temperatures for tracking the changes in diffuse patterns. Results show a highly disordered stacking of layers. However, subtle modulation of the intensity along the streak hints on some additional correlations. A tilting angle (≈1.5 degrees) of diffuse streak might be related to the twist angle between twins and to the small strain between layers.

Magnetic Frustration in Magnetoelectric Hexaaluminates $PrMgAl_{11}O_{19}$

<u>Kumar S.</u>, Elias A., Colman R., Klicpera M., and Bastien G.

Abstract. Geometric frustration and strong quantum fluctuations in spin systems can lead to exotic magnetic states such as quantum spin liquids (QSL), which lack conventional spin freezing. The realization of QSL states is a significant challenge in condensed matter physics. Recently, QSL was proposed in the triangular lattice antiferromagnet (TLAF) $PrZnAl_{11}O_{19}$ based on specific heat, neutron scattering, and muon spectroscopy on polycrystalline samples [1]. We report the single crystal growth and study of the sister compound, $PrMgAl_{11}O_{19}$. Specific heat and magnetization measurements down to 0.4 K show no magnetic order despite strong antiferromagnetic correlations indicated by a large negative Curie–Weiss temperature. Magnetization data reveal strong magnetic anisotropy suggesting proximity to the Ising limit, favoring the formation of QSL. Magnetic entropy analysis using nonmagnetic $LaMgAl_{11}O_{19}$ confirms effective spin S= 1/2. Additionally, low-temperature specific heat follows a power-law dependence, indicating a gapless QSL ground state in $PrMgAl_{11}O_{19}$.
[1] H. Bu, Phys. Rev. B 106, 134428, 24 October 2022

Synthesis, Characterization, and Second Harmonic Generation of 2D SnS_2 Layers

<u>Peheliwa V.M.</u> and Ma. Y.-R.

Abstract. In two dimensional (2D) materials, Second Harmonic Generation (SHG) is used to identify layer numbers, crystal orientation and phase transition. SnS_2 is a 2D semiconductor with applications in optoelectronics. We grew SnS_2 crystals using chemical vapour transport. The optical properties of exfoliated flakes and stacked twisted heterostructures were characterized using SHG. I will show that SHG is a vibrant tool to probe 2D materials [1].
[1] Peheliwa Adv. Optical Mater. 11, 2300395 (2023)

Exploring Electrical and Magnetic Properties of Single Crystal NiBr2

<u>Qureshi P.A.</u>*, *Hovancik D., Pospisil J., and Sechovsky V.

Abstract. In this study, we explore the structural, electrical, and magnetic properties of a single crystal of NiBr2, aiming to uncover its predicted multiferroic behavior. NiBr2 single crystals were grown via chemical vapor transport, with stoichiometric amounts of elements. Structural analysis via powder X-ray diffraction confirmed NiBr2's trigonal crystal structure (space group R-3m). Specific heat data revealed two anomalies, indicating magnetic phase transitions: an antiferromagnetic transition at Néel temperature TN = 44 K and an order-to-order transition at T = 22.5 K to a helical incommensurate antiferromagnetic structure. Microscopic analysis confirmed NiBr2's hygroscopic behavior. A suitable single crystal was exfoliated to the nanometer range, confirmed by atomic force microscopy, for studying single-layer optical and ferroic properties. Low-temperature Raman and terahertz spectra exhibited anomalies, correlated with changes in electrical, magnetic, and lattice properties, to be discussed in detail.

Qubit-environment Entanglement in Time-dependent Pure Dephasing for Transmon Qubits

<u>Strzalka M.</u>*, *Filip R., and Roszak K.

Abstract. We generalize the methods for quantification of system-environment entanglement that were previously developed for interactions that lead to pure decoherence of the system to time-dependent Hamiltonians. We use them to study the evolution of qubit-enviroiment entanglement for superconducting transmon qubits. This allows us to describe complex dependencies between the buildup of classical and quantum correlations associated with switching between entangling and non-entangling decoherence.

2DES - Ultrafast Spectroscopy with Independent Spectral and Time Resolution

Bouda K.

Abstract. A classic problem with most spectroscopic techniques is the uncertainty between energy and time — the short duration of a pulse in time leads to a wide spectrum and poor spectral resolution. Two-dimensional electronic spectroscopy (2DES) uses three femtosecond excitation pulses with a tunable delay to “fool” the uncertainty principle. Therefore, we can measure spectra with a resolution of up to tens of reciprocal centimeters and we can examine ultrafast processes such as internal conversion or vibrational relaxation. 2DES gives us one more additional really important advantage — the measurement provides information not only about gaps between energy levels, but even about the energy transfer between these levels in the system. So, we are able to see which energy states are interconnected and with which rate constant the energy transfer occurs between them. These properties make 2DES an ideal technique for examining ultrafast processes in photosynthesis, such as energy transfer in phycobilisomes or behaviour of the first steps of energy transfer in photosystems.

Substrate Dependence of Defect-Engineering with Helium Ion Microscopy in Molybdenum Disulfide Monolayers

***Bukhari A.**, Pirker L., Hlawacek G., and Frank O.*

Abstract. Defects in two-dimensional materials (2DM) present an as of yet unanswered question in terms of their influence on the properties of materials. Since the concentration of defects present in a 2DM has been shown to impact their behaviour, creating defect-engineered 2DMs provides another avenue towards devices tailor-made for specific applications.[1] Here we introduce defects in precise positions, with controlled fluences, in monolayers of molybdenum disulfide (MoS2) using helium ion microscopy.[2] We characterise the dependence of the optical and electrical properties of the 2DM on the concentrations of defects created with a range of methods that include optical spectroscopies and atomic force microscopy-based methods.[3] Gaining further insight into the role that structural defects play in determining the behaviour of a 2DM brings us one step closer to rational design when it comes to tailoring the properties of defect-engineered 2DMs. References:

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[2] S. Kretschmer, M. Maslov et al. ACS Appl. Mater. Interfaces 36 (2018) 30827.
[3] J. Li, T. Joseph et al. Adv. Funct. Mater. 18 (2022) 2110428.

Mechanical Regulation of Metabolism in Liver Cancer Cells

***Cale A.**, Elblova E., Uzhytchak M., Andelova H., and Oleg L.*

Abstract. Physical factors, such as the stiffness of the extracellular matrix (ECM), significantly influence cell functions. Tumorigenesis is linked to ECM stiffening, affecting its development and other functions. We hypothesize that mechanical stresses disrupt cellular organelles, impacting on cell functionality. Fluorescence microscopy reveals that liver tumor cells' metabolic activity, mitochondrial dynamics, and lipid droplet turnover are affected by ECM stiffening, highlighting the link between mechanical stress and cellular metabolism in cancer progression.

Molecular Simulations of Layered Double Hydroxides

Novotny R.

Abstract. Layered double hydroxides are crystalline materials with a layered structure, which have gained attention thanks to their ability to host various anions. Their use ranges from the removal of toxic anions from the environment or hosts for pesticides to disinfectants and drug delivery. Experimental methods used to study LDH include NMR or X-ray diffraction. In this talk, we will focus on computational methods that complement experiments and help us gain insight into the structure of LDH-based systems.

Ultra-Low Fouling Polymer Brush Interfaces for Biomedical Applications

Pilipenco A., Subbiahdoss G., Forinova M., Romanyuk O., Spasovova M., Reimhult E., and Vaisocherova-Lisalova H.

Abstract. Novel antifouling coatings with tailored zwitterionic and non-ionic moieties significantly mitigate bacterial biofilm formation (Staphylococcus epidermidis and Pseudomonas aeruginosa). These coatings enhance macrophage mobility, and support mammalian cell interactions without increasing cytotoxicity, thereby enhancing the biocompatibility and longevity of polymer brush biointerfaces for biomedical applications.

Nonlinear Optical Spectroscopy of Electron–Phonon Coupling

Ptacek M. and Mancal T.

Abstract. Recent experimental and theoretical research on photosynthetic complexes emphasizes the significance of electron–phonon coupling in spectroscopic signatures of chlorophyll molecules. Quantum chemical computations have identified three key vibrational modes that are involved. That falls beyond the scope of standard theoretical models due to their limited computational scalability. My goal is to devise an improved approach so that even nonlinear spectroscopic experiments of large molecular complexes can be simulated at this level of theory.

Dynamic Tuning of MoS_2 Photoluminescence via Thickness Modulation of CrSBr in Van der Waals Heterostructure

Sahu S., Varade V., Kesarwani R., Pirker L., Frank O., Vejpravova J., and Velicky M.

Abstract. This study investigates the tunability of photoluminescence (PL) properties of molybdenum disulphide (MoS_2) in a heterostructure composed of MoS_2 and chromium sulphide-bromide (CrSBr). By systematically varying the thickness of CrSBr in proximity of MoS_2 and employing various spectroscopic techniques, we explore the dynamic modulation of the MoS_2 PL intensity and spectral composition. Our findings reveal intriguing changes in MoS_2 PL behaviour correlated with different thicknesses of CrSBr, shedding light on potential tailoring of the optoelectronic functionalities within van der Waals heterostructures. This work contributes to the understanding of the interplay between 2D materials and offers insights for future applications in optoelectronic devices.

Exploring the Conformational Transitions of Adenylate Kinase in a Crowded Milieu

Samanta M.* and *Timr S.

Abstract. Inside living cells, enzymes are exposed to a highly crowded and complex environment. These conditions, which are far from those in conventional in-vitro assays, can alter enzyme activity in non-trivial ways. To understand these effects, detailed insights from molecular simulations are highly desirable. In this work, we employ all-atom molecular dynamics (MD) simulations to investigate the impact of molecular crowding on adenylate kinase (AK3L1) as a model enzyme. We describe how crowding affects conformational changes and substrate binding, which are linked to enzyme activity. The results help to rationalize previous experimental observations reporting altered kinetic parameters of adenylate kinase in the presence of crowding. Our study is a step towards a better understanding of enzyme behavior within the complex milieu of living cells.

Modelling Solvation and Solute–Solute Interactions Through C-NNP and Active Learning

***Simko P.* and Marsalek O.**

Abstract. Describing solvation and solute–solute interactions is crucial for many applications in molecular modelling. In this work, we use the committee neural network potentials based on the Behler–Parrinello or NequIP architecture, together with active learning, to obtain a model of solvation and solute–solute interactions at the DFT level of theory. With these models, we will compute free energy profiles of chosen collective variables at ab initio accuracy, using steered molecular dynamics.

Antifouling Polymer Brushes for Improved Analytical Performance in Biosensing

***Vrabcova M.*, Spasovova M., Forinova M., Pilipenco A., Houska M., Fekete L., Lynn N.S., and Vaisocherova-Lísalova H.**

Abstract. Zwitterionic poly(carboxybetaine) brushes are promising functional antifouling coatings for label-free biosensing in complex biological media. This study investigates properties of these brushes prepared by surface-initiated atom transfer radical polymerization. Their analytical performance and storage stability are evaluated using surface sensitive methods such as spectroscopic ellipsometry, infrared reflection–absorption spectroscopy, surface plasmon resonance, and atomic force microscopy.

F-5 PHYSICS OF SURFACES AND INTERFACES

$BaTiO_3$ Characterized at the Atomic Scale: Surface Structure and Its Ferroelectric Behavior

***Albons Caldentey L.*, Wrana D., Alexander A., Sokolovic I., and Setvin M.**

Abstract. $BaTiO_3$ is a promising material for prospective use as a ferroelectric catalyst, as well as a model system for investigating fundamental properties and phenomena that manifest at the surface of ferroelectric materials. Specifically, ferroelectric polarization may be used to separate or trap charges at the surface of the crystal, as well as to alter the surface structure and chemical properties. In this work we demonstrate that one can prepare a pristine $BaTiO_3$(001) surface by cleaving single crystals in UHV and characterize it with atomic resolution using the qPlus nc-AFM/STM. We show that the surface can be BaO or TiO_2 terminated, both presenting charged intrinsic defects that interact differently with adsorbed molecules. Moreover, by cleaving crystals polarized in preferential directions, we have proven that the surface structure depends on the ferroelectric structure of the bulk crystal during cleave. We demonstrate a reversible ferroelectric polarization of the surface both at the atomic and microscopic scale is possible with the electric field of the tip applied above the surface.

Electrochemical Deposition of Platinum Nanoparticles

***Kalabis D.* and Yakovlev Y.**

Abstract. In this work we study platinum nanoparticles made by electrochemical deposition. Previous studies shown possibility of nanoparticle preparation and morphology control by varying deposition parameters. We prove deposition of 50–90 nm nanoparticles on glassy carbon support with different shape and properties by controlling potential, deposition and rest time (3–27 ms) for pulse deposition. We observed nanoparticles with SEM and tested their catalytic behaviour in electrochemical cell (RDE).

Nonthermal Plasma Air Purification and Catalyst Regeneration

Ksanova J., Cimerman R., Satrapinskyy L., and Hensel K.

Abstract. This research investigated the experimental system combining air purification and catalyst regeneration by nonthermal plasma. The system first uses plasma catalysis to remove a model pollutant (toluene) from the air, and second regenerates the spent catalyst using plasma. This cycle was repeated three times for each catalyst (TiO_2, Pt/Al_2O_3). The toluene removal efficiencies obtained with regenerated and non-regenerated catalysts were compared. The gaseous products of the experiments were monitored using FTIR. Analysis of the solid products deposited on the surface of the catalysts was carried out using SEM.

Enhancing the Stability of ORR Catalysts Through Rhodium Doping

Orsag M.

Abstract. Proton exchange membrane fuel cells (PEMFCs) represent a promising technology for a future net-zero economy. Nevertheless, enhancing the stability of PEMFC cathode catalysts remains a significant challenge. In this study, Pt–Rh bimetallic catalysts with varying compositions were prepared using magnetron sputtering and extensively characterized with the aim of developing cathode catalysts with improved activity and stability.

Enhancing Ceria Catalysts: Structural and Electronic Insights into $FeO_x/CeO_2(111)$ and $Au/FeO_x/CeO_2(111)$ Systems

Oveysipoor S., Piliai L., Castro-Latorre P., Pchalek F., Ormos M., Kosto Y., Khalakhan I., Skala T., Alemany P., Vorochta M., Neyman K.M., Bruix A., Matvija P., and Matolinova I.

Abstract. Catalytic activity of ceria-based catalysts can be improved by transition metal oxides, such as iron oxide. In this study, we prepared well-defined $FeO_x/CeO_2(111)$ model surfaces and investigated their structure and electronic properties using PES, STM, LEED, and DFT. We used this surface as a support of Au nanoparticles, known for their activity in low-temperature CO oxidation. We studied the stability of the nanoparticles in the near-ambient pressure conditions of CO, O_2, and their mixture.

Engineering High-index Surfaces Using Ion Erosion for Model Electrocatalytic Studies

Samal P.K., Skvara J., Fusek L., Ronovský M., Johanek V., Lykhach Y., Libuda J., Brummel O., and Myslivecek J.

Abstract. High index surfaces on Pt (111) with different step densities were prepared in UHV using ion erosion method. The step densities were determined using Scanning tunneling microscopy and step sites were characterized using cyclic voltammetry. Electrochemical adsorption/desorption processes were studied as a function of step density. Further, the Hydrogen evolution reaction and Oxygen evolution reactions were studied on these surfaces. An enhancement in OER activity due to steps on Pt was observed.

Design and Implementation of PCTFE EC Cell

Skvara J., Samal P.K., and Myslivecek J.

Abstract. We have designed a new type of electrochemical cell which is suitable for providing in-situ electrochemical experiments with arbitrary electrolyte. The cell was then tested on a model experiment with ion eroded metal surfaces.

F-6 Quantum Optics and Optoelectronics

Attosecond Physics and Advanced Control of High Harmonic Generation in Condensed Matter

Gindl A. ***and Kozak M.***

Abstract. The interaction of intense ultrashort laser pulses with matter in the strong-field regime of nonlinear optics enables the study of electron excitations with high temporal resolution. We report on the development a two-colour nonlinear interferometer which coherently combines the laser field with its third harmonic frequency for tailoring the nonlinear optical response of solids in the strong field regime. The newly introduced spectral interferometry technique enables the measurement of the emission delay of high harmonic photons from the sample on attosecond time scale.

Proposal for Second Harmonic Generation in a Herriott Cell

Satra S. ***and Novak O.***

Abstract. Herriott cells are a type of multipass cells, usually used in spectroscopy or pulse compression to increase the length of interaction path of a pulse with nonlinear gas medium. Recently, they were used to generate second harmonic frequency with nanosecond pulses. Here, we present our plans for generation of second harmonic frequency in a Herriott cell with continuous-wave laser and several results obtained by numerical simulations that we performed.

F-8 ATMOSPHERIC PHYSICS, METEOROLOGY AND CLIMATOLOGY

Automatic Detection of Overshooting Tops and Their Properties Using Neural Networks

Dolezalova A., Seidl J., and Stastka J.

Abstract. Overshooting tops (OTs) are important phenomena at the cloud top of convective storms that can indicate their severity. Because of that, it is useful to have an automatic tool for OT detection. In this contribution, we will present a NN model for OT detection and estimation of its height. The model was trained on about 10000 OT samples with known height above the cloud top, viewed by MSG SEVIRI instrument.

Monitoring Extreme Meteorological and Pollution Events in Prague: A Station Data-Based Analysis

Ramatheerthan S.K., Peiker J., Crespo N.M., and Kozubek M.

Abstract. In the current climatic scenarios, the European continent faces numerous extreme events related to both meteorology and pollution. This study analyses the manifestation of these events in Prague by utilizing data from various monitoring stations within the capital city. Specifically, we examined two recent significant extreme occurrences: a high-temperature anomalous condition during midwinter (January 2023) and the impact of a wildfire in České Švýcarsko National Park (July 2022) on the particulate matter (PM10) concentrations in Prague. For the meteorological analysis, we analyze the temperature, wind speed and humidity data, focusing on the differing impacts across various parts of Prague. For the wildfire analysis, we utilized PM10 values from stations inside Prague, including those at the Troja Campus, aiming to assess pollution levels. Our findings indicate that both extreme events were effectively captured by the instruments, highlighting the capability of our monitoring network to provide crucial data for further studies.

F-9 PARTICLE AND NUCLEAR PHYSICS

Investigation of the Four-Top-Quark Production

Hidic N.

Abstract. The top quark is the heaviest elementary particle in the Standard Model (SM) and has a strong connection to the SM Higgs boson as well as potentially new particles in various theories beyond the SM. It is therefore relevant to study rare processes involving the top quark, such as the production of four top quarks. This talk will give an overview of the measurments and searches of the four top quark events. The talk will focus primarily on four top quark events produced at the Large Hadron Collider in proton–proton collisions at center of mass energy 13 TeV. The SM predictions for the cross section of the four top quarks will be discussed. The talk further focuses on the measurement of the four-top-quark cross section in proton–proton collisions using the all-hadronic decay channel. An investigation of parton-level and particle-level observables will be summarized. An implementation of the likelihood-based kinematic reconstruction will be discussed as a way to improve kinematic reconstruction. A study comparing multijet samples generated with different generators will be presented. The performed studies help in the discriminate separation between signal and background.

Periodic Driving of Collective Quantum Systems

Honsa L.

Abstract. Recently, exited-state quantum phase transitions (analogues of ground-state quantum phase transitions in excited spectra) were identified in periodically driven quantum systems. Critical phenomena in finite systems occur only in the form of precursors (hints of nonanalytic behaviour that emerge in the infinite-size limit). We study their formation, destruction and relation to chaos. To probe the eigenvectors of the Floquet operator, we plot the inverse participation ratio and the Peres lattice.

F-12 PHYSICS EDUCATION AND GENERAL PROBLEMS OF PHYSICS

Qualitative Analysis of High School and University Textbooks on Thermodynamics and Statistical Physics

Blovsky T.

Abstract. In this research, focused on selected topics on thermodynamics and statistical physics in secondary and higher education, we aim to find out how well the basic concepts are defined in high school and university literature. Critical analysis of available textbooks and teaching materials was carried out. By examining the accessible Czech and foreign language textbooks, as well as multimedia sources (web pages, computer simulations etc.), associated with teaching thermodynamics and statistical physics at both levels, we probe the quality of the learning sources. Based on this research, new educational materials will be prepared and piloted in secondary schools and universities.

F-13 PHYSICS OF NANOSTRUCTURES

Nanomagnets with Coupled Spin Crossover

Srivastava K.A., Vejpravova J., Veverka M., Sandoval S., Kalbac M., and Prchal J.

Abstract. Magnetic ferrite nanoparticles have garnered significant attention in research circles due to their potential applications in fields such as magnetic disc drives, spintronics, ferrofluids, and drug delivery systems. Our objective is to explore the magnetic properties and transition temperature associated with spin crossover phenomena. Here, Cobalt ferrite nanoparticles were synthesized using thermal decomposition technique and coated with SCO complex. Structural studies were done using TEM. To investigate the influence of magnetic anisotropy and interaction of ferrite nanoparticles with the SCO polymer, we used SQUID magnetometer. The study will extend to examining the spin hybrid SCO-NP architecture under similar conditions.