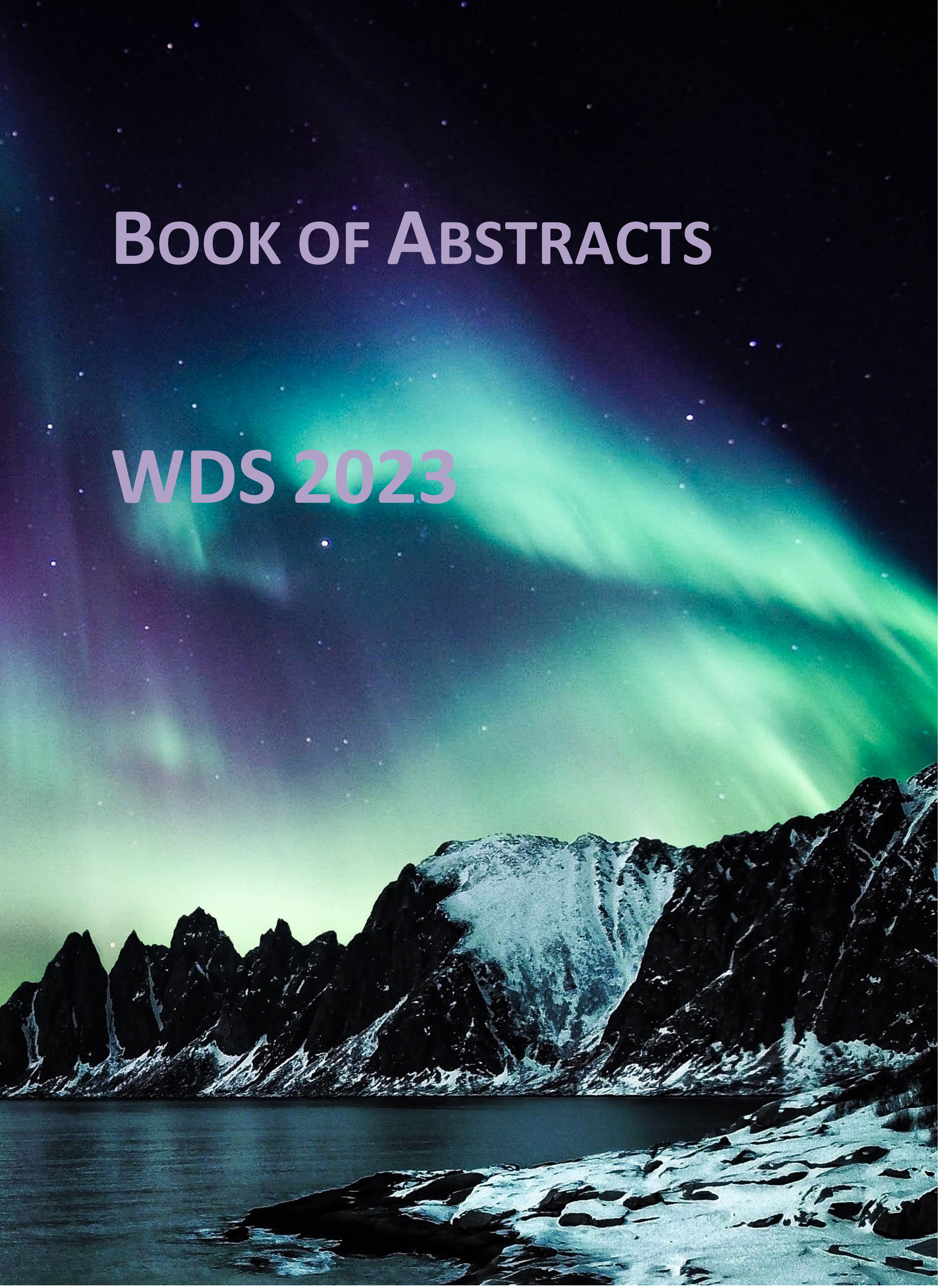
BOOK OF ABSTRACTS

WDS 2023



Book of Abstracts

Week of Doctoral Students 2023

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CONTENTS

Abstracts are listed alphabetically
by presenting authors in each section.

F-1 THEORETICAL PHYSICS, ASTRONOMY AND ASTROPHYSICS

The Role of Interacting Multi-fluid in Modelling Relativistic Stars

Agarwal U.

Abstract. I present the derivation of a dimensionless, frame-independent formulation of the TOV equations that model the interior of a relativistic stellar object (e.g. neutron star). These equations form an autonomous system of ordinary quasi-linear differential equations which are not plagued by singularities and allow for easy extension to more general sources than perfect fluids. To further our understanding of the structure of neutron stars, we write the TOV equations for the case of multiple sources and further introduce interaction between different fluids. Resolutions strategies, such as generating theorems and reconstruction algorithms, instrumental for deriving analytical solutions, are developed and some analytical solutions are derived. During my PhD, this work will be extended to the study of compact stellar objects in near-equilibrium states and the inclusion of more realistic sources e.g. electromagnetic fields.

Algebraically Special Robinson–Trautman Geometries in Quadratic Gravity

Astudillo N.

Abstract. In the context of quadratic gravity, we use the Newman–Penrose formalism to formulate constraints on the admissible geometries belonging to the Robinson–Trautman class that simultaneously admit an algebraically special form of the curvature tensors. In particular, we are interested in the Weyl type N spacetimes, where we aim to find the solution to such constraints.

Observational Properties of FS CMa Stars

***Bermejo-Lozano I.* and Korčáková D.**

Abstract. FS CMa stars are a group of stars that present the B[e] phenomenon: permitted and forbidden emission lines, and infrared excess. These characteristics are produced by the large amount of gas and dust surrounding the star. This group of stars is populated by many different types of stars (e.g,, post-AGB, X-ray binaries, post-mergers, etc.). Our object of study is the last one: post-merger stars. The aim of this talk is to show the main observed properties of these post-merger objects.

Study of Ultra High Energy Cosmic Ray Anisotropies

Gálvez Ureña A.

Abstract. My objective is to study the Ultra High Energy Cosmic Rays (UHECRs) anisotropies using their harmonic cross-correlations with other fields such as matter distribution, neutrinos... With this purpose I use galaxy catalogs to define the sources, learn to use publicly available codes to calculate the energy losses as UHECRs travel through intergalactic space and develop my own code to predict the deflections that the Galactic Magnetic Field causes on the UHECRs arrival directions.

Indication of Radial Pulsations in the B-Supergiant Star HD14134

Guha S., Kraus M., Sanchez Arias J. P.

Abstract. The B-supergiant HD14134 displays variability that suggests pulsations and stellar wind variations. We combine photometry from the TESS mission with optical spectroscopy to search for radial pulsations. These modes have been proposed to facilitate mass-loss. From our measurements of equivalent width ratios of temperature sensitive lines we find indication of radius changes implying radial pulsations. The observed H-alpha line variations indicate wind variability as well.

Lyapunov Exponents of Electrically Charged MadMax Black Holes

Menšíková J. and Hale T.

Abstract. MadMax theory is a theory of non-linear electrodynamics. In a recent paper, thermodynamical properties of electrically charged MadMax black holes were studied. In this talk, we will probe them more by discussing their phase transitions in terms of Lyapunov exponents calculated for null and time-like geodesics.

Exact Spacetimes in Three-dimensional Gravity

Podolský J. and Papajčík M.

Abstract. Recently, Einstein's general relativity in 2+1 dimensions has attracted a lot of attention, mainly because quantization of such spacetimes is in principle possible. A systematic study of exact solutions of this theory is thus desirable. In 2+1 gravity the only vacuum solutions are either Minkowski, de Sitter or anti-de Sitter spaces, according to the value of the cosmological constant. For locally non-trivial geometries, we must also include a matter field. In this contribution we derive all spacetimes in 2+1 gravity containing an electromagnetic field, while also including a non-vanishing cosmological constant. We also investigate some properties of the obtained solutions, in particular we identify an important class of charged black holes.

Observation of the Open Clusters in the UV

Ramezani T. and Paunzen E.

Abstract. My thesis is related to observing the new open clusters in Ultraviolet and analyzing their data. We observed by the DK1.54 meter telescope in Chile and the CASLEO telescope in Argentina in the ultraviolet filter because it is the best way of observation for Reddening. Reddening is independent of distance, age, and metallicity. Our method is Isochrone fitting for 250 open clusters. For Isochrone fitting, we need Reddening. Our goals are:
(1) Are these new open clusters that we observed with DK1.54 and CASLEO telescopes real open clusters or not?
(2) Do Reddening for all our observed clusters. The Gaia Data Release 3 will allow us to precisely study known Galactic open clusters. We collected the available photometric and astrometric data and then observed 250 open clusters with DK1.54 and CASLEO telescopes photometrically in the Ultraviolet region in a homogeneous way. With these data, a first homogeneous census of the open clusters in the Milky Way using Ultraviolet photometry can be derived and compared to the literature. In my poster, I will show what I have done until now.

HD Flows at the Apex of an Astropause

Saddal K. S. and Nickeler D. H.

Abstract. The Astrosphere is the interaction region between the stellar wind and the interstellar medium, and the astropause is the tangential discontinuity that separates both flows. This analysis attempts to model the astropause using ideal HD in the subsonic regime. Using stream functions to describe such flows, we obtain a second-order elliptic PDE called the Grad-Shafranov equation, and the solutions are approximated by choosing a Laurent series ansatz. The resulting flow configurations are studied.

On the Coherent Evolution of Stellar Structures in the Galactic Centre

Singhal M., Subr L., and Haas J.

Abstract. Previous works have shown that nearby Keplerian stellar orbits can undergo a coupled secular evolution in a combined axially and spherically symmetric perturbative potential. This coupled evolution causes initially formed coherent stellar structures to survive for a relatively long time, even with gradual changes in their global properties. A prime example is the observed system in the Galactic Centre, which consists of the young stellar disc, gaseous torus and the embedded spherical cluster. In this work, we extend the original analysis to closer vicinity to the SMBH, where the orbits of the S-stars are supposed to be perturbed by the young stellar disc, and post-Newtonian corrections to the gravity of the central SMBH.

Non-thermal Processes in Protostellar Jets

Tunç Ö., Araudo A., and Müller A. L.

Abstract. Massive protostars have associated bipolar outflows with velocities of 500 km/s. The interaction of such outflows with the surrounding medium can create strong shocks, resulting in areas of non-thermal radio emission. This emission is synchrotron in nature and has been detected from the jets of some massive protostars, indicating the presence of relativistic electrons and strong magnetic fields. In this study, I focus on modelling the non-thermal emission produced in the jet associated with the massive protostar IRAS 18162-2048. I explore under which conditions relativistic particles are accelerated at the termination shocks of the protostellar jets and produce the non-thermal emission detected by radio interferometers. I will discuss my progress, providing an overview of this subject and outlining my future plans.

A Case Study of ACV Variables Discovered in the Zwicky Transient Facility Survey

Faltová N., Kallová K., Prišegen M., Staněk P., Supíková J., Xia C., Bernhard K., Hümmerich S., and Paunzen E.

Abstract. Magnetic chemically peculiar (mCP) stars exhibit complex atmospheres that allow the investigation of the interplay of atomic diffusion, magnetic fields, and stellar rotation. A non-uniform surface distribution of chemical elements and the non-alignment of the rotational and magnetic axes result in the variability of several observables. Photometrically variable mCP stars are referred to as α2 Canum Venaticorum (ACV) variables.

F-2 PHYSICS OF PLASMA AND IONIZED MEDIA

Investigation of the Threshold Dynamo Phenomenon in the MHD-shell Model

Abushzada I., Yushkov E., and Sokoloff D.

Abstract. The well-understood process of dynamo theory describes the mechanism of the formation of large-scale magnetic fields in stars and planets. However, there is also a very similar process of hydrodynamic energy transfer to magnetic energy, known as small-scale or turbulent dynamo. This process describes magnetic energy generation on scales smaller than the characteristic correlation length of the random velocity field. The equation for the small-scale dynamo was first derived by Kazantsev and Kraichnan for the simplest case without differential rotation and mirror asymmetry. In our work we consider the generation process using a shell approach. This model allows for the analysis of the cascade of hydrodynamic and magnetic energy across the spectrum, accumulation of energy, and its dissipation over time. Our results suggest that the observed generation is a small-scale dynamo process, and we investigate the growth rates of magnetic energy for different magnetic Reynolds numbers. We also answer the question of whether the small-scale dynamo observed within the shell approach is a threshold phenomenon similar to the classical Kazantsev approach.

Development of Scintillator Stack Spectrometer for Laser-Plasma Experiments at PALS

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

Abstract. The study of bremsstrahlung radiation in laser-matter interaction provides insightful information of hot electron dynamics for applications such as inertial fusion and laboratory astro-physics. The paper presents preliminary results of scintillators as x-ray spectrometers tested at PALS using a 50 µm thick Sn target irradiated by kilo-Joule laser ($I \approx 10^{16}$ W/cm^2). Experimental measurements provide temperature and energy distribution of emitted bremsstrahlung during laser-solid interaction.

Modeling the Location and Shape of the Magnetopause Using Machine Learning Methods

***Aghabozorgi Nafchi M.**, Němec F., Pi G., Němeček Z., Šafránková J., Grygorov K., and Šimůnek J.*

Abstract. Empirical models for predicting the location of the magnetopause currently in use typically rely on the identification of individual magnetopause crossings, and their fitting by a predefined magnetopause shape. Although the assumed analytical shape formula may be rather complicated and general, it represents a principal apriori limitation of the model. We remove this limitation by applying an approach based on an artificial neural network. A large data set of about 40,000 dayside magnetopause crossings is used for the training, resulting in a direct data-driven model predicting the magnetopause radial distance as a function of relevant solar wind parameters without any additional assumptions. We further discuss an alternative approach, where the spacecraft occurrence in the respective neighboring regions (magnetosheath/magnetosphere) is analyzed and predicted in place of the magnetopause crossings themselves. This allows the usage of principally all the data measured, and effectively removes the sampling bias due to uneven radial distance data coverage.

Testing of High Temperature Vacuum Insulations

***Barton P.**, Fukova S., and Varju J.*

Abstract. COMPASS-Upgrade is the new tokamak being built at IPP Prague, featuring 80 K cooled coils and a 770 K heated reaction vessel. As cooling efficiency is low at cryogenic temperatures, thermal insulation between cold and hot parts is an important part of the device. We have designed several possible thermal insulations and built a small testing apparatus to verify their suitability and performance. In this poster, we present the first measurements of several different insulations.

Electric and Magnetic Field Variations Associated with Martian Plasma Depletion Events

***Basuvaraj P.*, Němec F., Regoli L., Fowler C., Němeček Z., and Šafránková J.**

Abstract. Martian Plasma Depletion Events (PDEs) are sudden, localized depressions in ionospheric plasma concentration that occur mainly in the nightside, southern hemisphere, and regions with stronger magnetic fields. In this study, we analyze in-situ electric and magnetic field observations from the Mars Atmospheric and Volatile Evolution (MAVEN) spacecraft to investigate the possible formation mechanisms of PDEs. Our analysis reveals that the electric field changes associated with PDEs are mainly electrostatic, deviating from previously reported ionospheric irregularities at Mars. We also find that the low-frequency electric field wave power, integrated between 2 to 100 Hz, increases by up to two orders of magnitude during the PDEs. Furthermore, we observe that the ionospheric plasma within the depleted region is strongly magnetized, as determined by the ratio of the gyro to collision frequency. Our findings suggest that PDEs are unique ionospheric structures that differ from other ionospheric irregularities and possibly share some similarities with terrestrial plasma bubbles.

The Electron Induced Fluorescence of Nitrogen

***Blaško J.*, Országh J., Stachová B., and Matejčík Š.**

Abstract. The electron induced fluorescence of nitrogen was studied. The energy range of electrons was from 6 to 100 eV and the spectral range was from 330 to 1030 nm. 2D spectral map was measured by CCD camera. This kind of data for such large spectra and energy range were published for the first time. 2D spectral map allows extraction of (i) electron energy resolved emission spectra of N_2, (ii) determination of the absolute values of excitation-emission cross sections and (iii) excitation-emission functions for any of the molecular bands or atomic lines present in the spectra.

Simultaneous Observations of Whistler Mode Waves by the DEMETER Spacecraft and the Kannuslehto Station

***Drastichová K.*, Němec F., Manninen J., and Parrot M.**

Characterization of Functional Layers Prepared via Plasma Polymerization at Atmospheric Pressure

Ďurčányová S., Kováčik D., Stano M., Stupavská M., Zahoran M., and Zahoranová A.

Abstract. Preparation of thin, functional coatings is an important process in various industries. One way to prepare such coatings is plasma polymerization (PP), which uses a plasma source to deposit polymer-like layers. This work aims to study and optimize PP of hexamethyldisiloxane at atmospheric pressure using a Diffuse Coplanar Surface Barrier Discharge (DCSBD) to create protective hydrophobic layers. The prepared layers were characterized with surface diagnostics such as WCA, SEM, ATR-FTIR and XPS.

Kinetic Monte Carlo Simulations in Physics of Thin Films: from Growth to Electronic Properties

Gabriel V., Redondo J., Wrana D., V., Setvín M., Holý V., and Kocán P.

Abstract. In this contribution, we present two applications of kinetic Monte Carlo (kMC). First, we developed a model to simulate pulsed laser deposition (PLD) growth of multiferroic perovskite. PLD is widely used due its possibilities to create smooth films due to the high temperature of impinging particles. However, this feature makes it difficult to simulate. Second, we applied the kMC method to study polaron diffusion in doped hematite, which is a key process in photoelectrochemical water splitting.

Time-resolved Action Spectroscopy for Studies of State-changing Collisions Between H_3^+ and H_2 in an Ion Trap

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

Abstract. We present the design and early results from an ion trap experiment, studying nuclear-spin changes in H_3^+ and H_2 collisions. The emphasis is on the unique design of the ion trap, enabling precise observation and control of the trapped ions. We use time-resolved action spectroscopy to measure the time-dependent rotational population of H_3^+ ions. A state-to-state kinetic model guides our experimental design, improving the reliability of our observations.

Study of Dust Impact Signals at Mars Using MAVEN/LPW Observations

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

Abstract. Our study focuses on analyzing short pulses detected by the Langmuir Probe and Waves (LPW) instrument onboard the Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft. We present a preliminary statistical analysis of 360,000 waveforms recorded in 2015, which consists of approximately 16,000 events representing both solitary waves and the most probable dust impacts. Distinguishing solitary waves from dust impact signals by an automatic routine is a difficult task thus, the study presented in this paper suggests a methodology to separate dust impact signals from solitary bipolar electric field structures. We further discuss these events generated by dust impacts and solitary waves under different operation modes of electric field probes, spacecraft potentials, and distance of the spacecraft from the surface of Mars.

Using Ablative Imprints and Phase Recovery Algorithm to Characterise Focused Laser Beams

***Jelinek S.**, Dudzak R., Burian T., Hajkova V., Juha L., and Chalupsky J.*

Abstract. The ablation imprints method is a well-established approach to thoroughly characterising fluence distributions of focused short-wavelength free-electron laser beams. We extended the method into visible and near-infrared wavelengths. Further, we used a conventional method to measure fluence distributions in the laser caustic. We applied a phase recovery (PhaRe) algorithm to extract the phase and simulate the beam's propagation in the caustic. We compared the results obtained by these methods.

Penning Ionization of N_2 by Helium Metastable Atoms

***Kassayová M.**, Uvarova L., Dohnal P., Roučka Š., Plašil R., and Glosík J.*

Abstract. Penning ionization was performed on Cryo-SA-CRDS apparatus in connection with measurement of N_2^+ recombination. Based on the development of the concentration of electrons and N2+, we have determined the rate coefficients of the reaction of N2 and helium metastables in the afterglow under certain conditions.

Lightning Activity over Central Europe Observed by Detector LIS Onboard ISS in Years 2017–2022

***Kolinska A.**, Kolmasova I., Price C., and Santolik O.*

Abstract. The study analyzes lightning activity over central Europe using optical data from the Lightning Imaging Sensor (ISS–LIS) from 2017 to 2022. The yearly flash rates and spatial distribution are investigated. The ISS–LIS data are also combined with ground-based measurements from Shielded Loop Antenna with a Versatile Integrated Amplifier (SLAVIA) located in the northwestern part of Czechia and data from the World Wide Lightning Location Network (WWLLN).

Characterization of Tokamak Magnetic Footprints Using Melnikov Integral

***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 introduce the faster Melnikov integral method. The first-order approximation error inherent in the Melnikov integral is tackled via a second-order approximation. A unique approach for managing strike point perturbations is also presented.

Mechanics of the Dual-frequency Paul Trap

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

Abstract. We are reporting the studies on the dynamics and kinematics of a charged particle confined in a dual-frequency Paul trap. From the description of classical mechanics, we derive a quantum mechanical counterpart satisfying the fundamental commutation relation. We then develop the Hamiltonian. To describe the quantum dynamics of a single ion in a multi-frequency field, we adopt the modified Lindstedt–Poincare-based classical dynamics solution and check the possibility with a state space approach-based solution. To discuss the dynamics in more practical circumstances, we involve the effects from both static stray electric fields and oscillating phase mismatch conditions.

Grafting of Acrylic Acid on Microporous Polypropylene Membranes Using Plasma Activation in Argon or Oxygen for Application as Separators in Alkaline Water Electrolyzers

<u>Kutka M.</u>, Satrapinskyy L., Kovacik D., and Stano M.

Abstract. Microporous polypropylene membranes were activated in a low-pressure radiofrequency (RF) discharge in argon or oxygen and subsequently grafted with acrylic acid. Grafted membranes were characterized by gravimetric grafting degree, FTIR, electrical resistance in 30 wt.% KOH aqueous electrolyte, and hydrogen diffusion through membrane in alkaline water electrolysis cell. Long-term aging test was conducted to evaluate the effect of plasma composition on durability of the grafted membranes.

Electric and Resonance Properties of a Coaxial Electron–Ion Trap

<u>Lausti N.</u>, Kumar V., and Hejduk M.

Abstract. We present a design for a radio-frequency trap for ions and electrons. Our purpose is to research sub-Kelvin plasma. The trap is based on a coaxial resonator, rarely seen in particle trapping, despite a potentially higher quality factor. The resonator is fed via a capacitively coupled input pin. Electric properties of the pin, the coupling and the resonator have been computationally studied. The resonator quality factor is 15 000, seven times more than in previous comparable designs. This decreases needed input power and device heating.

Application of Ion Mobility Spectrometry for Laser Desorption of Explosives

<u>Maťaš E.</u>, Sabo M., and Matejčík Š.

Abstract. In this study, we investigated detection of explosives such as TNT, PETN, RDX using laser desorption (LD) technique using ion mobility spectroscopy (IMS) with corona discharge (CD) ion source from different surfaces (ceramic, drywall, aluminum, stainless steel, PVC). The ionisations of samples were performed in negative polarity CD using dopant gases C_2Cl_6 and $(NH_4)_2CO_3$. Detection of explosives was possible from all surfaces. The best of LDO of TNT was determine to 50 ng from ceramic.

Characterization of Field Emission Current Generated in Microdischarges

Maťašová M., Klas M., Čermák P., and Matejčík Š.

Abstract. Generation of plasma in micrometric electrode distances is one of the ways how to ensure its homogeneity. In such gaps, the high electric field intensities can be achieved $\approx 10^8$ V/m and field emission phenomena occur. Therefore, the main objective of this study is the characterization of field emission current generated in microgap breakdown system between palladium electrodes. For precise emission current measurements, our experiments were provided in vacuum $\approx 10^{-4}$ Pa.

Solving Plasma Dispersion Relation for the Type III Solar Radio Burst

Mičko J., Souček J., Píša D., and Santolík O.

Abstract. Program WHAMP was chosen to model the electron beam instability generating Langmuir waves in the case of the Type III solar radio bursts observed by the Time Domain Sampler (RPW-TDS) on the Solar Orbiter. We solved the dispersion relation for the case of a fast electron beam propagating in solar wind plasma for a range of beam velocities; and for both zero and non-zero angle between the magnetic field and the k-vector. We compare the wave polarization from the numerical model with observed data.

Investigation of Tin Removal for Liquid Metal Tokamak Divertor by Low Pressure Argon Arc with Hot Tungsten Cathode System

Mishra H., Mašek T., Turek Z., Čada M., Hubička Z., Kudrna P., and Tichy M.

Abstract. The influence of a low-pressure argon arc with a hot tungsten cathode on the thin tin film with a negative bias voltage applied during the plasma treatment was investigated to study the tin film removal from the sample surface. Samples were prepared on a stainless-steel substrate using DC magnetron sputtering and hybrid HiPIMS assisted with electron cyclotron wave resonance (ECWR). During treatment an optical emission spectroscopy was employed to detect and characterize the emission line of tin spectrum and the electron density and temperature were measured by Langmuir probe. Morphological study by a scanning electron microscope helped to gain insight to the mechanism of tin removal from the substrate. In addition, elemental compositions of tin layer before and after treatment was measured by an energy dispersive X-ray spectroscopy. We believe that this study contributes to finding a proper treatment for tin removal from plasma facing surfaces of tokamaks using tin in the liquid metal divertor.

Nickel–Cobalt Oxide Catalysts Prepared by a Combination of Electrochemical Process and Plasma Jet Sputtering

Naiko I., Ostapenko A., Čada M., Kudrna P., Hubička Z., Jirátová K., and Kudrnová H.

Abstract. Metal oxide-based catalysts were prepared on stainless steel meshes by combining electrochemical deposition and plasma sputtering of Ni and Co with a molar ratio 1:1. Electrochemically deposited Ni-Co layers followed by annealing showed lower catalytic activity in comparison to sputtered layers. The highest activity was obtained in the case of catalysts prepared by a combination of both preparation procedures, electrochemical and sputtering.

Experimental and Theoretical Studies of Gas Phase Ion Mobility and Energetics: Protonated Saturated and Unsaturated Aldehydes in Helium

Omezzine Gnioua M. and Španěl P.

Abstract. To understand the ion-molecule reactions for trace gas mass spectrometric analysis, theoretical calculations and experimental measurements were carried out for selected volatile organic compounds (VOC) classes. Quantum chemistry density functional theory, DFT, calculations provided the geometries and energetics of ions. Enthalpies of aldehyde molecules and ions resulting from their protonation were calculated at the B3LYP 6-311++G(d,p) level of theory for the standard temperature and pressure for several optimized structures of each of the ions. Mobilities of protonated aldehydes under different reduced electric field intensities (E/N) were determined by Selected Ion Flow Drift Tube Mass Spectrometry (SIFDT-MS) and compared with the hard-sphere cross-section approximation theory. The aim is to accurately determine the rate coefficients for forward and backward proton transfer reactions between different aldehydes $AH^+ + B \rightleftharpoons BH^+ + A$ from which other thermochemical parameters can be reliably obtained, such as equilibrium rate constants and the changes in Gibbs free energy.

Dynamic Sheath Behavior of Langmuir Probe Under Different Pressures

Palacky J. and Roucka S.

Abstract. Langmuir probes are used to determine various plasma parameters, which are crucial for correct predictions of plasma behavior. In certain Langmuir probe applications there is a need to do fast measurements, because there is a temporal limit of the measured phenomenon or the probe can be damaged while it is exposed to plasma for a longer period of time. We use the particle model to find the characteristic times of the plasma stabilization and charged particle behavior near the probe after potential changes on the probe and we are observing the whole plasma dynamics related to this process.

Study of Transient Spark Discharge and Electrospray Interaction for Plasma Activated Water Generation

***Pareek P.* and Janda M.**

Abstract. We investigated the plasma-activated water (PAW) properties when the electrospray (ES) microdroplets interact directly with transient spark discharge (TS) in one stage system (1SS) and when TS discharge is separated by the ES in two stage system (2SS). The study was carried out with pure O_2, humid N_2, and synthetic air as the input gases. Time-integrated optical emission spectra, pH, gas phase and liquid phase RONS were investigated in the above-mentioned conditions. The NO_2^- (aq) concentration in PAW increased with input energy density in 2SS with dry and humid synthetic air. High concentrations of H_2O_2(aq) in PAW were produced in 1SS in comparison to 2SS. Moreover, the PAW in 1SS with humid O_2 generated higher concentration of H_2O_2(aq) (4 mM) in comparison to humid N_2 (1.6 mM). Results showed that direct interaction (1SS) of microdroplets and plasma is necessary for production of high concentrations of H_2O_2 (aq) while in indirect treatment (2SS) NOX (aq) species dominate. I would like to show my gratitude towards the Faculty of Mathematics, Physics, and Informatics (Comenius University Bratislava) for providing extraordinary scholarship for the representation of this work.

Investigation of Solar Wind Turbulence and Interplanetary Shock Interactions Across Multiple Heliocentric Distances

Park B., Pitňa A., Šafránková J., Němeček Z., Kruparova O., and Krupar V.

Abstract. Recent space missions, e.g., Parker Solar Probe, have revealed novel aspects of solar wind turbulence near the Sun. Simultaneous observation from multiple spacecraft has facilitated a comprehensive analysis that reveals new insights into the evolution of solar wind turbulence. We explore the intricate interaction between solar wind turbulence and interplanetary shocks across various heliocentric distances. Harnessing data from multiple spacecraft missions, i.e., Parker Solar Probe, Solar Orbiter, Stereo-A, Wind, ACE, and DSCOVR, we present a detailed characterization of shock transitions and the change of turbulent properties across the shock near the Sun and beyond. We analyze magnetic field fluctuations observed by multiple spacecraft using a continuous wavelet transform (CWT). Evolution of the fluctuations at and between different heliodistance is estimated.

Explanation of Disruptions After L–H Transitions Observed in COMPASS

Peterka M., Seidl J., Markovič T., Casolari A., Havlíček J., Hron M., Pánek R., and Tskhakaya D.

Abstract. In the presence of HFS error field in COMPASS, disruptions due to locked modes are observed shortly after the L–H transition, in much higher densities than those predicted by a scaling of the critical density mode-locking in L-mode. This is explained in this contribution by the rapid decrease of the natural rotation frequency of a 2/1 mode after the L–H transition, which is detected by a detailed analysis of the Fourier spectra of magnetic saddle coils.

Statistical Study of ULF Fluctuations Close to a Dayside Bow Shock

***Salohub A.**, Šafránková J., Němeček Z., and Pi G.*

Abstract. Our study focuses on spatial distributions and a level of compressibility of the ULF fluctuations observed in front of the bow shock. We use a statistical approach based on the THEMIS B and C spacecraft working during the 2008–2009 years in the magnetospheric mode. The amplitudes of fluctuations are quantified by the standard deviations of the magnetic field strength, $\sigma|B|$, magnetic field components, σB, and the ion density, σN calculated over 10-minute intervals and normalized to the averaged magnetic field strength and density, respectively. The study reveals (i) similar behavior of fluctuations of the compressive component of the magnetic field and ion density; (ii) different behavior of the compressive and Alfven-like components of magnetic field fluctuations leading to increasing compressibility in front of the bow shock; and (iii) a strong dependence of fluctuation compressibility on the Alfvenic Mach number of the incoming solar wind.

Electron Induced Fluorescence of CO

***Stachová B.**, Országh J., Blaško J., Bromley S., Bodewits D., and Matejčík Š.*

Abstract. Optical emission spectroscopy was used to study the electron-induced fluorescence of CO. CO is abundant in extra-terrestrial bodies such as comets, centaurs, or interstellar gas clouds. The emission spectrum following electron impact on CO was studied in a crossed-beam experiment and measured at several electron energies in the range from 5 to 100 eV within the wavelengths of 275–1030 nm. Excitation-emission functions of several emission lines and bands were measured and their threshold energies were estimated.

Synchrotron Radiation Model for Cherab

***Tomes M.**, Ficker O., Seidl J., and Tomesova E.*

Abstract. The presented synchrotron radiation model is an addition to the library of Cherab's radiation models and follows the ideology used in both Cherab and Raysect. This makes it applicable to a wide range of diagnostics and allows it to cover many features of synchrotron radiation observed in Tokamak discharges. To make the model variable, the two main inputs into the model were made as general as possible. The first is a 6D electron distribution function and the second is a magnetic field in the form of a 3D vector function. These inputs in combination with the Raysect's general 3D ray tracing capabilities make it possible to treat a wide range of phenomena. For example, observable effects of 3D magnetic fields on camera images and reflections of the synchrotron radiation from the first wall. The contribution will give a brief description and discussion of the model possibilities and examples of forward models of 2D CCD camera images.

Electron Density Measurements Through Wave Cutoff Probe and Optical Emission Spectroscopy in Hollow Cathode Jet

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

Abstract. The electron density is one of fundamental parameter indicating characteristics of processing plasma. Therefore, the precise measurement of plasma density has become one of the major missions especially in reactive plasma with oxygen. Among invented diagnostics, a cutoff probe looks more suitable for iron oxide deposition, because of simplicity and durability of probe system. High measurement accuracy of plasma density is achieved by measuring the cutoff frequency ωc (~plasma frequency, ωp) on a transmission microwave frequency (TMF) spectrum without complex equations and assumptions. Mechanism behind cutoff probe has been introduced. The identification of iron spectral lines in argon+oxygen gas discharge in hollow cathode plasma jet were achieved through optical emission spectroscopy. Keywords: Electron density, Cutoff probe, Plasma frequency, Hollow cathode plasma jet, Optical emission spectroscopy

Probe Diagnostics of Titanium Nitride Plasma in Hollow Cathode Jet at Low Pressure

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

Abstract. We present Langmuir probe and curling probe diagnostic of a DC discharge generated by titanium hollow cathode in the mixture of argon and nitrogen at room temperature and at low pressure. We present the dependences of electron density on the applied power and the argon-nitrogen flow ratios in the mentioned system together with a qualitative discussion of the obtained results.

Measurement of Kinetic Temperature of H_3^+ Ions in 22-pole Ion Trap

Uvarova L., Rednyk S., Hernández Alvarez O. E., Roučka Š., Dohnal P., Plašil R., and Glosík J.

Abstract. H_3^+ ions are widespread in the interstellar medium and play an important role in cosmic chemistry. The 22-pole ion trap was used in the present study. This trap may be cooled to 10 K by a closed-cycle helium cryocooler. In order to determine the population of rotational quantum states of H_3^+ ions, we used the Laser Induced Reaction (LIR) of H_3^+ with Ar. The kinetic temperature of H_3^+ ions was obtained from the Doppler broadening of absorption line of H_3^+ ions at different conditions.

Dependence of Foreshock Structures on Solar Wind Conditions

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

Abstract. The turbulent foreshock region upstream of the quasi-parallel bow shock is dominated by waves and reflected particles that interact with each other and create a large number of different foreshock phenomena. The creation of these structures is expected to be connected with the pristine solar wind and its interaction with the foreshock region. Xirogiannopoulou et al. (2023) defined three types of structures (plasmoids, SLAMS, and mixed structures) and in this work, using measurements by the Magnetospheric Multiscale Spacecraft (MMS) and OMNI solar wind data, we try to explore their connection with the solar wind. We present a statistical analysis of the occurrence rate of these structures both in common and extreme solar wind conditions. We try to argue that pristine solar wind does not directly affect the formation of these structures. Nevertheless, we discuss how the aforementioned subsolar foreshock structures are highly dependent on the change of solar wind inside the foreshock region.

F-3 PHYSICS OF CONDENSED MATTER AND MATERIAL RESEARCH

Physical Properties of Uranium-Hafnium Alloys and Their Hydrides

Devanaboina S. V. V. U. K., Koloskova O., Havela L., and Mašková-Černá S.

Abstract. Hydrogenation of gamma-U phases alloyed by Zirconium (Zr) forms a single stable phase of alpha-UH3 hydride with 20 % of Zr. To investigate whether Hafnium (Hf) supports the stabilization of bcc alpha-UH3 phase similar to Zr, we synthesized $U_{1-x}Hf_x$ alloys with x = 0.10, 0.30, 0.40 by arc melting and hydrogenated them by exposure to high pressure of H_2 gas. XRD analysis revealed that beta-UH3 is the dominant phase for 10 at% Hf, but it is gradually reduced with increasing Hf concentration up to 40 at%, where alpha-UH3 exists as a majority phase. Magnetization studies are currently underway.

Raman and Infrared Response of Van der Waals Ferromagnet VI3

Hovančík D., Repček D, Borodavka F., Kadlec Ch., Carva K., Doležal P., Kratochvílová M., Kužel P., Kamba S., Sechovský V., and Pospíšil J.

Abstract. We report measurement of THz lattice and magnetic resonances in van der Waals ferromagnet VI3 using Raman and infrared spectroscopy. By mapping the phonon frequencies as a function of the temperature we found clear signatures of the structural transition at 79 K. The enhanced variations of phonon frequencies observed near the FM phase onset temperature ≈ 50 K indicate the strong magneto-elastic coupling. Below Curie temperature, two Raman active modes appear showing significant softening in the narrow interval around the second structural transition ≈ 30 K associated with the magnetic structure modification. The DFT calculation-based phonon spectra were compared to the observed one to deduce the structural modifications in low-temperature phases. Below ≈ 30 K, a highly energetic FM resonance in a terahertz (THz) range was detected. The observed THz FM resonance in VI3 is a promising indicator of the application potential of 2D vdW FM in ultrafast THz spintronics even though it was previously considered an exclusive domain of antiferromagnets.

On the High-temperature Oxidation of Complex Concentrated Alloys

<u>Jača E.</u>, Pešička J., Hotař A., Daniš S., and Minárik P.

Abstract. Complex concentrated alloys are attracting considerable interest due to their potential applications under extreme conditions. We developed equimolar alloy FeAlCrV possessing promising mechanical properties up to 800 °C. However, its oxidation resistance is unsatisfactory. Therefore, we focused on the possible improvement of this alloy and further characterization of its oxidation behavior. A series of FeAlCr-Ni-V alloys was made to examine in detail the effect of vanadium which seems to play a crucial role in the kinetics of the oxidation.

Investigation of New S_{eff} = ½ Pyrochlore Antiferromagnets: Structural and Magnetic Properties of NaCdM2F7 (M = Cu^{2+}, Co^{2+})

<u>Kancko A.</u>, Colman R. H., Giester G., and Correa C. A.

Abstract. The A2B2X7 pyrochlores (X = O, F), materials containing A- & B-site sublattices of corner-sharing tetrahedra, offer a rich playground in the frustrated magnetism community due to the plethora of exotic magnetic ground-states (eg., spin-ice, spin-glass and spin-liquid states). In particular, the utilization of low-spin (S = ½) magnetic ions on the pyrochlore lattice is of interest due to their large quantum fluctuations at low temperature, which serve to destabilize long-range magnetic order, potentially resulting in a disordered, dynamic highly-correlated quantum spin-liquid ground-state. I will present the structural and magnetic properties of two new members of the family, $NaCdCu_2F_7$ (S = ½) and $NaCdCo_2F_7$ (S_{eff} = ½), comparing them with the previously investigated members.

Theoretical Study of the Open-shell Character of Acenes: Effects of Length, Dynamical Correlation, and Substrate

***Kumar M.*, Soler D., and Jelinek P.**

Abstract. In this study, we investigate the open shell character of acenes with varying lengths, ranging from 2 to 14 fused benzene rings. Our focus is on the radical character and singlet-triplet Energy gap. We utilize DFT to predict the ground state of the acenes, and we find that acene of length 6 has an open shell ground state of the series. But experimentally, the spin-excitation was only confirmed in the acenes of length 13. Moreover, DFT also overestimates the singlet-triplet gap significantly than the observed experimentally. To gain a deeper understanding of the system, we employ a state-of-the-art method, the CASCI. To explore the effect of dynamical correlation and sigma orbitals on the spin-excitation value, we investigate the impact of the substrate on the molecule using an image charge approximation. However, this correction was insufficient, so we implemented a four-site metal chain model coupled weakly with the molecule, allowing only small virtual excitations. In summary, our study provides a comprehensive understanding of the open-shell character of acenes and the singlet-triplet gap. It sheds light on the substrate's impact on the molecule's electronic properties.

Fabrication and Measurement with Helmholtz Resonators in Superfluid ^{4}He

***Novotný F.*, Talíř M., Midlik Š., and Varga E.**

Abstract. In this work, we study strongly turbulent flow of 2D confined superfluid ^{4}He in steady state using Helmholtz resonators. The Helmholtz resonator is a SiO_2 chip with circular cavity 5 mm in diameter and two necks, which connect the cavity to the bulk ^{4}He. We designed and fabricated 4 different types of necks. Due to high requirements of purity, the whole nano-fabrication process had to be carried out in the specialized clean-rooms (CEITEC Brno). Flow inside the chip is induced using Helmholtz resonant modes. After reaching a critical drive or velocity, we can observe a transition between a laminar and turbulent state of the fluid. Our first experiments show clear dependence of this transition on the type of the neck.

Qubit-environment Negativity Versus Fidelity of Conditional Environmental States for an NV-center Spin Qubit Interacting with a Nuclear Environment

<u>Strzałka M.</u>*, *Kwiatkowski D., Cywiński L., and Roszak K.

Abstract. We study the evolution of qubit-environment entanglement, quantified by Negativity, for spin qubits interacting with a nuclear environment. We compare it with the evolution of the Fidelity of environmental states conditional on the pointer states of the qubit, which can serve as a tool to distinguish between entangling and non-entangling decoherence in pure-dephasing scenarios. The two quantities show remarkable agreement during the evolution in a wide range of system parameters.

F-4 BIOPHYSICS, CHEMICAL AND MACROMOLECULAR PHYSICS

Towards Rydberg States Using Ab-initio Approach

Andreides ***B.***

Abstract. The presentation will introduce a *nouvelle ab-initio* approach for the description of atomic and molecular Rydberg states. Although based on a trivial model only, the method is capable of providing an unprecedented number of lithium atom Rydberg states with accuracy being on a par with competitive state-of-the-art techniques. Further development plan for the new approach, as the topic of my PhD program, will be drawn in the talk as well.

Shedding Light on the Influence of Structural Defects on the Behaviour of Two-dimensional Materials

Bukhari A.

Abstract. Two-dimensional (2D) materials such as graphene and transition-metal dichalcogenides have been studied extensively across many fields owing to the rich physics that occurs in atomically thin layers, leading to significant leaps in our understanding of their properties. These can be influenced by a wide range of factors, one such being structural defects, where the nature of their impact on material behaviour requires further exploration. Facile methods to quantify the structure-property relation of defects are needed, as ultra-high vacuum systems are currently needed to resolve the structure of defects down to single atoms. We aim to develop a toolbox for describing changes induced by defects, created by irradiation, involving a set of techniques that can be used in ambient conditions, while still enabling the characterization of individual defects. These methods include optical spectroscopies in conjunction with a range of atomic force microscopy-based techniques. Untangling the relationship between distinct kinds of defects and their influence over a materials property allows for informed decision-making when tailoring the properties of devices based on defect-engineered 2D materials.

Towards Modulating Near-field Plasmonic Coupling for Enhanced Optical Spectroscopy

***Cattozzo Mor D.**, Auer S., Morozov Y., Jaik T., Diehl F., Jonas U., and Dostalek J.*

Abstract. Metallic nanostructures for plasmonic amplification of weak optical spectroscopy signals (such as fluorescence, Raman scattering, etc.) are typically made static. A possible route to expand the tools of plasmon-enhanced spectroscopy tools is presented, based on responsive hydrogel materials that act as artificial muscles and provide on-demand, reversible reconfiguration of plasmonic hotspots. In particular, an array of Au NPs is moved towards or from an Au layer to turn on or off the plasmonic effects and at the same time allow for molecule capture and probing.

Anti-fouling Polymer Brush-coated Surface-based Biosensors: Synthesis, Characterization, and Experiments

***Cirik V.**, Spasovová M., Lisalová H., and Lynn N. S.*

Abstract. Anti-fouling polymer brush (PB) coated surface-based biosensors offer improved detection performance for label-free sensing over conventional sensing techniques. In this work, we use microfluidic reactors to synthesize PB surfaces (via surface-initiated atom transfer radical polymerization) having qualities that exceed the state-of-the-art, which further allows for massive reductions in chemical waste and synthesis cost. Novel oxygen removal systems based on immobilized glucose oxidase and copper-based flow cells are also proposed. PBs are characterized using FTIR, ellipsometry, quartz crystal microbalance, and surface plasmon resonance.

The Interactions Between DNA Nanostructures and Hepatic Cells

Elblová P., Smolková B., Uzhytchak M., Dejneka A., Lunov O., and Stephanopoulos N.

Abstract. DNA nanotechnology due to capability of controlling structures on nanometer scale offers unique opportunities for biomedical applications, e.g. smart drug carriers, immune boosters, and imaging agents. However, the technology still requires basic knowledge on understanding cell-DNA nanostructures interactions for future successful transfer to clinical use. Thus, we studied the interaction of novel functionalized DNA nanostructures (DNs) with hepatic cells. We found that surface decoration of DNs with aurein peptide results in augmenting immunogenic capabilities of DNs.

Maximization of Correlation in Self-propeled Systems

Giraldo-Barreto J. and Holubec V.

Abstract. Could the group behaviors of animals such as bacteria, insects, or birds observed in nature emerge by local optimization of a target function? To give a preliminary answer, we consider agents moving with fixed speed and allow them to choose their orientation at the next discrete time that maximizes their local velocity correlations. The resulting group behavior is cohesive and highly polarized for low enough noise. Besides, the famous Vicsek model of flocking is a limiting case of our dynamics.

Micromanipulation as a New Instrument for Research of Biomembrane Structure and its Mechanical Properties

Johanovská Z.

Abstract. In cells, various membrane events are influenced and sometimes even controlled by the changing of the membrane tension. Micromanipulation brings new, so far not fully explored possibilities to biomembrane research, as it enables direct modifications of membrane mechanical properties of vesicles (GUVs), simulating cell membrane. The combination of micromanipulation with other methods such as fluorescence microscopy will allow us to open the door to other exciting experiments we plan to perform.

Electromagnetic Chips for Analysis and Function Modulation of Molecular Nanostructures

***Kůrka P.**, Cifra M., and Havelka D.*

Abstract. Knowledge of the electromagnetic properties of molecular nanostructures is essential for understanding the interaction of electric fields with biosystems and developing novel biomedical diagnostic and therapeutic methods. This presentation will aim to show why electromagnetic microstructured chips compatible with advanced optical microscopy are the perfect tools for the dielectric probing and influencing of biological matter.

Structural Studies of Self-assembling Polymers on Crystal Surfaces

***Manikandan M.**, Nicolini P., and Hapala P.*

Abstract. Hydrogen-bonded polymers like DNA, RNA and protein are key for building the complex molecular machines which constitute all living organisms. In our research project we try to extend these principles to the field of on surface chemistry and design novel photosensitive polymer templates that can facilitate the self-assembly of molecular-electronics circuits in concert with photolithography. To achieve a polymer with optimal structure and thermodynamics properties,we investigate different hydrogen bonding residues similar to nucleobases which are attached to diacetylene backbone. In order to balance speed and accuracy of my calculations, I employ a combination of quantum chemistry methods together with classical force-fields.

Molecular Simulations of Halloysite Nanutubes

***Pšenička M.* and Pospíšil M.**

Abstract. Halloysite is very often considered as mineral with so called kaolinite's structure with one major difference, halloysite mostly presents a spiral tubular morphology instead of platy one. We will present a new structural point of view for the explanation of halloysite's morphology based on molecular dynamics and DFT calculations in combination with experimental methods.

A completely new program was created for the generation of various structural models from platy, cylindrical to spiral shape structures as halloysite presents. The software is based on mathematical or real physical quantities that are derived from experimental measurements. Subsequently, representative model of halloysite nanotube (HNT) was used to study loading of drug molecules inside HNT structure in order to describe controlled drug delivery process.

Thermodynamic Uncertainty Relations in a System with Inertia

***Puga Cital E.* and Holubec V.**

Abstract. Thermodynamic uncertainty relations are general inequalities that lower bound fluctuations of thermodynamic currents, and thus the performance of thermodynamic machines, by the accompanying entropy production rate. However, they may not hold for systems with inertia. We study a simple experimentally motivated model of an autonomous Brownian heat engine based on a weakly damped pendulum to determine if its performance can break the limitations imposed by the thermodynamic uncertainty relations.

Large-area Mechanically-exfoliated Two-dimensional Materials on Arbitrary Substrates

***Sahu S.**, Haider G., Rodriguez A., Plšek J., Mergl M., Kalbáč M., Frank O., and Velický M.*

Abstract. Layered materials play a crucial role in modern device-based applications due to their unique properties, which can be unlocked through the exfoliation of layered crystals to monolayers. While several exfoliation methods have been developed, Au-assisted exfoliation has recently shown potential for producing large-area monolayers. However, this method promotes charge transfer that limits (opto)electronic applications of exfoliated materials. Here, we present a method of preparing large-sized monolayer flakes using Au-assisted exfoliation followed by chemical etching of Au. We characterize the samples using photoelectron and optical spectroscopic techniques and fabricate field-effect transistors and photodetectors to demonstrate the suitability of our method for large-area optoelectronic devices. Our findings highlight the technique's ability to preserve the material's intrinsic physical and chemical properties, opening up new possibilities for a wider range of applications.

Using Principal Component Analysis to Better Understand G-quadruplexes

***Sgallová R.**, Volek M., Srb P., Veverka V., and Curtis E. A.*

Abstract. G-quadruplexes are noncanonical nucleic acid structures with widespread biological roles. We are exploring the functional and structural diversity of a 496-member DNA G-quadruplex library. Each of these sequences was tested for five different biochemical properties, and the resulting dataset was analyzed using principal component analysis. This revealed a wealth of information about the relationships among primary sequence, multimeric state, and biochemical function.

Investigating FGF2 Translocation on Vesicles

***Vandana*, Macharová S., Riegerová P., Kapusta P., Steringer J. P., Müller H. M., Lolicato F., Nickel W., Hof M., and Šachl R.**

Abstract. Fibroblast Growth Factor 2 is a protein that has many extracellular roles, such as wound healing, cell differentiation or metastasis. FGF2 is secreted from cells via an unconventional secretory pathway. In the presence of PI(4,5)P2 lipids, FGF2 oligomerises in the membrane, followed by in-membrane oligomerisation and pore formation. To study the protein pore formation process, we used synthetic free-standing lipid bilayers known as giant unilamellar vesicles (GUVs) to explore protein oligomerisation. Dual(+1) FCS approach can investigate protein oligomerisation in the (in-)membrane. To distinguish functional oligomers from dysfunctional aggregates, we present a single statistical molecule and individual vesicle assay for determining the brightness of individually diffusing in-membrane oligomers and correlating their oligomerisation state with membrane pore formation. Importantly, time-dependent membrane pore development was studied using a group of single vesicles. This approach allows for the correlation of in-membrane protein surface concentration change with the oligomeric state change.

F-5 Physics of Surfaces and Interfaces

Surface Characterization of the Ferroelectric Perovskite $BaTiO_3$ by AFM

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

Abstract. Characterization of BaTiO3 is an interesting field due to its ferroelectricity and surface chemistry. Specifically, ferroelectric polarization may be used to separate and trap charges at the surface of the crystal, as well as to alter the surface chemistry. In this work, we optimize the way to prepare a pristine $BaTiO_3$ surface by cleaving in UHV and characterize it with atomic resolution using the qPlus nc-AFM/STM. In addition, we demonstrate a reversible ferroelectric polarization of the material at the atomic scale, by application of the tip-sample bias voltage.

TERS: A Tool to Comprehend Phonon–Polaron Coupling in Perovskites

***Alexander A.**, Park Y., Shiotari A., and Setvin M.*

Abstract. Perovskite surfaces attract attention due to their promising properties like ferroelectricity, excess charge trapping, and the good ability to separate electro-hole pairs. Confinement of the excess charges in the ionic lattices induces distortions and results in the formation of quasi-particles called polarons. [*Franchini et al*., Nature Reviews Materials, 2021.] The poster will discuss the local structure of the doped $KTaO_3$ (001) surface. Here we attempt to track the polaronic nature of the surface using scanning tunneling microscopy (STM) in conjunction with tip-enhanced Raman spectroscopy (TERS) to understand the lattice distortion caused by the concentration of excess electrons in perovskite surfaces. This approach provides information about the active phonon modes on the specific area of the surface well as within the bulk. The TERS method contributes to a better understanding of the light-matter interaction at atomically precise junctions of the perovskite surface.

Reaction Mechanism of On-surface Synthesis of Non-benzenoid Nanographene: A Theoretical Study

***Chen Q.**, Soler-Polo D., and Jelínek P.*

Abstract. Non-benzenoid nanographenes have been shown to have interesting physicochemical properties, making them attractive for various applications. However, their synthesis is not trivial. Here, we report on an on-surface synthetic strategy for fabricating non-benzenoid nanographene containing different combinations of pentagonal and hexagonal carbocyclic rings. We employed QM/MM simulations to understand the reaction mechanism to synthesize various nanographenes. Our results provide a detailed understanding of the on-surface synthesis of NGs containing non-benzenoid topologies with tailor-made properties.

Physicochemical Properties of Cerium Oxide for Sensing Urea Molecules

***Deineko A.**, Kalinovych V., Mehl S. L., Matolinová I., Matolín V., and Tsud N.*

Abstract. There is a growing interest in electrochemical sensors based on inorganic materials for the detection of biomolecules, mainly because of the favorable characteristics such as high mechanical strength, electrical conductivity, high isoelectric point, large surface area, chemical inertness, non-toxicity, biocompatibility. We were characterizing the bonding of urea molecule to the cerium oxide by studying of the model systems which includes mono- and polycrystalline cerium oxide and molecules deposited in UHV conditions. The surface analysis was done by means of photoelectron spectroscopic techniques (SRPES, XPS, and NEXAFS). All measurements were performed at zero potential. They gave us information about the oxidation state of the cerium oxide, changes in the chemical state of the adsorbates, etc. The knowledge on urea interaction with the oxide surface will help to elucidate and understand the complexity of processes during the electrochemical reactions on ceria working electrode at 0 V potential.

Exploring the Behavior of Supported Ruthenium Nanoparticles Under Oxidative Conditions — A Model Study

Dinhová T. N., Vorochta M., and Matvija P.

Abstract. Supported Ru-based catalysts are typical oxidation catalysts that have been extensively applied in multiple processes. However, working conditions during the catalytic reactions cause chemical and structural changes in the catalyst, thus in its catalytic activity. Water is a common product of many catalytic reactions, including alkane, alcohol, and amine oxidation, and to understand its effects on the catalyst during the reaction, a model catalyst was prepared — metallic Ru nanoparticles (NPs) on the oriented $CeO_2(111)$ surface — and in-situ studied by NAP-XPS and STM under elevated temperatures in O_2 or in the mixture of O_2 and H_2O. The systematic study of the behavior of Ru NPs on a model ceria surface showed gradual oxidation of metallic NPs, their dispersion into clusters and single-atoms, and finally, their desorption from the surface. A slower progression was observed in the presence of H_2O at temperatures below 300 °C, explained by a blocking effect of adsorbed water molecules, disabling oxygen to adsorb and oxidize Ru on CeO_2.

Suppressing Peierls Transition by Topological Protection in Nanographene–Polyacetylene Complexes

Lozano M. A., Soler D., Xinnan P., Jiong L., and Jelinek P.

Abstract. In this work, we demonstrate that the Peierls distortion in polyacetylene chains can be effectively suppressed under certain circumstances. Namely, we found a certain class of nanographene structures connected by polyacetylene chains in which the Peierls distortion does not take place. We have employed total energy DFT calculations as well as a model Hamiltonian to understand criteria that induce or suppress the Peierls transition. In particular, the one-electron tight-binding model, which includes a weak electron-phonon coupling, reveals that the Peierls distortion is governed by very simple topological properties of the lattice of nanographene. This finding suggests that a criterion based merely on the connectivity of the lattice of the nanographenes is sufficient to predict whether or not the Peierls transition takes place.

CO Oxidation at Near-ambient Pressure Using Gold Supported on Iron–Ceria Mixed Oxide System

Pchálek F., Oveysipoor S., Piliai L., Vorochta M., Matvija P., and Matolínová I.

Abstract. Au supported by powder Fe-modified ceria is known for its superior catalytic activity in low-temperature CO oxidation compared to Au supported by pure ceria. In this study, we prepare well-defined epitaxial Au/FeO/CeO_2(111) surfaces, and we study them using STM and NAP-XPS techniques in UHV and after exposure to CO, a 1:1 CO and O_2 mixture, and O_2. Our results show that the presence of FeO layer hinders a long-range diffusion of Au and prevents the formation of large Au clusters on the surface.

Exciton Lifetime of Decoupled Phthalocyanine Molecules

Sagwal A., Doležal J., Ferreira R., and Švec M.

Abstract. A few layers of NaCl decoupling layer on metal are sufficient to prevent the nonradiative quenching of the excited state in phthalocyanine and observe fluorescence in the far field from the molecule located in the junction of a scanning tunneling microscope. First attempts to measure the lifetimes of exciton in the nanocavity suggested lifetimes of hundreds of picoseconds but later studies pointed towards a transient charge state lifetime involved in the electroluminescence excitation process and estimated the lifetime to be several orders of magnitude lower, due to the Purcell effect of the plasmonic nanocavity. Here, we use a pulsed supercontinuum laser to reveal the radiative decay of the excited state of the molecules with and without the presence of nanocavity.

Co Thin Layer on STO and its Removal by Boiling in Water

***Škvára J.**, Samal P. K., Mysliveček J., and Johánek V.*

Abstract. The $SrTiO_3$ (STO) is gaining on popularity in the surface physics study field due to its potential use in photocatalysis and heterogeneous catalysis. Recently, we introduced the STO in our lab by performing a simple experiment, where a Co thin layer was deposited on STO(001) by PVD and heated. Its response to high temperature was monitored by XPS, STM and LEED. Afterwards, the surface was cleaned by a new method, in which the sample is boiled in water and annealed in UHV. The method was proved to be faster, cheaper and comparably efficient as other methods previously reported in literature.

F-6 Quantum Optics and Optoelectronics

Influence of Substrate and Passivation on Graphene Transport Properties

__Fridrisek T.__, Shestopalov M, Dedic V., and Kunc J.

Abstract. High-quality epitaxial graphene (EG) can be grown on the surface of silicon carbide (SiC) by thermal decomposition of silicon. The possibility of optical gating of EG and the effect of the surrounding environment on the electrical properties and stability of EG were investigated. The surrounding environment includes the SiC substrate, atmosphere, and passivation by oxide layer. EG in the shape of Hall bars were prepared using e-beam lithography. Time-dependent and spectral photoconductivity measurements were performed on non-passivated and passivated samples.

Terahertz Spectroscopy as a Tool for Probing Ultrafast Spin Currents in Altermagnets

__Jechumtál J.__, Jasenský K., Olejník K., Kubaščík P., Scheffler D., Reichlova H., De Luca G., Němec P., and Nádvorník L.

Abstract. Recent studies have shown nonrelativistic analogues to various ferromagnetic (FM) phenomena in freshly discovered compensated magnetic phase — altermagnets (AM) [*Šmejkal et al.*, Phys. Rev. X , 2022], but their ultrafast versions at THz frequencies remain unknown. In my work, I use THz time domain spectroscopy to study the spin-polarization and spin-splitter effects in D-wave altermagnets using effect of spintronic THz pulse emission [*Seifert et al.*, Nat. Phot., 2016] as well as the effect of rotation of THz polarization via altermagnetic anomalous Hall effect.

AFM Characterization of Perovskites Materials

__Khytko M.__

Abstract. Silicon/Perovskites tandem solar cells are the future of photovoltaics. The ongoing challenge is their upscaling while remaining over 30% conversion efficiency, most probably due to local inhomogeneities in the active perovskite layer. Microscopic characterizations will help to solve this challenge.

Time-resolved Interference of Electron States for Imaging of Optical Near-fields

***Koutenský P.* and Kozák M.**

Abstract. The main disadvantage of electron microscopy is its temporal resolution. The goal of the presented dissertation thesis is to explore a possible solution for achieving both femtosecond temporal and picometer spatial resolution of electron microscope by employing nonelastic interaction between electron beam and optical intensity grating. The main complication arises from designing a phase stable optomechanical device, which is to be placed inside of the chamber of the electron microscope.

Development of Biosensor Integrating Plasmonic and Electrochemical Methods

***Liu T.*, Tichý I., Čapková M., Hemmerová E., and Homola J.**

Abstract. We present a novel biosensor integrating plasmonic and electrochemical methods in a single platform. The integral component of the biosensor is the gold chip supporting surface plasmons and simultaneously serving as a working electrode for the electrochemical measurements. the chip is divided into four independent areas and coupled with a dedicated flow-cell. The flow-cell was designed to contain four flow channels, each of which incorporates silver/silver chloride reference and a graphite counter electrode. This design results in a multichannel biosensor platform integrating four independent channels with individual three-electrode systems providing simultaneous information about electrochemical characteristics and molecular interactions taking place in each channel. The developed biosensor was characterized by means of channel-to-channel and chip-to-chip variability, long-term stability, potential stability, and sensitivity. Finally, as a proof-of-concept, we performed a model bio-detection experiment demonstrating the applicability of the developed biosensor in the bioanalytical field.

Dynamic Control of Magnetism in Manganites

Malecek T., Melzer A., Guillaume A., and Veis M.

Abstract. As current electronics approaches its fundamental limits new paradigms are required. Among those spin electronics which offers faster and more efficient manipulation with information. Research into the properties of new materials is essential for the success of spintronics. This presentation offers insight into a handful of manganite materials (LSMO,LMO,MnTe) which have proven to be very interesting for future research.

Emergence of Straintronics Effects in Epitaxial Graphene

Rejhon M., Parashar N., Shestopalov M., Kunc J., and Riedo E.

Abstract. Emergent electronic phenomena, from superconductivity to ferroelectricity, and correlated many-body band gaps, have been observed by stacking and twisting atomic layers of Van der Waals materials. These twisted superlattices with emergent properties are based on exfoliated atomic layers deposited on a substrate and expertly mechanically twisted and aligned with the desired orientation. Here, we report on the spontaneous occurrence of straintronics effects in untwisted three-layer epitaxial graphene giving rise to surprising stripes of a few tens of nanometers with dissimilar conductivity.

Quantum Coherent Interaction of Free-electrons and Optical Fields

Streshkova N.

Abstract. In the last decade the efforts to combine the nanometer spatial resolution provided by electron microscopes and the femtosecond temporal resolution of ultrafast optical methods led to the emergence of ultrafast electron microscopy. The recent progress in the field shows that accelerated free electron waves can efficiently be manipulated in a coherent manner by optical fields into tailored quantum states. Here we present theoretical simulations for such interactions. We introduce the concept of imprinting a specific phase and intensity profile from the optical fields in a vacuum onto the electron beam to generate a so-called electron vortex beam (EVB). Such EVBs have the potential to become a sensitive probing tool for imaging the near-field of chiral nanostructures. Further utilizing the techniques of light shaping, we show that chirped optical pulses can be used to compress the spectral bandwidth of an electron pulse. We discuss the possibility of coherent transfer of optical information mediated by free electrons and its utilization in coherent cathodoluminescence, the design of new specialized light sources and single-nanocrystal micro-spectroscopy.

Magneto-optics of Materials with Antiferromagnetic Coupling

Vančík M.**, **Fakhrul T., Su T., Cho E., Ross C. A., and Veis M.

Abstract. The current computer technologies are reaching their physical limits. Demand for more efficient and faster devices, therefore, requires new solutions. Magnetic materials with antiferromagnetic coupling are getting much attention because of their attractive properties and can be used in various devices such as optoelectronic, spintronic and memory devices. Potential materials include ferrimagnetic garnets, rare earth orthoferrites and non-collinear antiferromagnets.

F-8 ATMOSPHERIC PHYSICS, METEOROLOGY AND CLIMATOLOGY

Towards Automatic Determination of Overshooting Top Heights from Satellite Imagery

***Doležalová A.*, Seidl J., and Šťástka J.**

Abstract. Overshooting tops (OT) are one of the phenomena on the cloud top of convective storms that can indicate their severity. In our work we use satellite imagery to detect OTs and to measure their height, which can be used as an indicator of the strength of the associated updraft. We focus on the analysis and extension of the database of OT occurrences and heights created by Ján Kaňák and will discuss means of automatization of the whole process.

Optical and Satellite Observations of Transient Luminous Events and Underlying Convective Storms

***Jírová M.*, Kolmašová I., and Popek M.**

Abstract. Convective storms are accompanied by a number of atmospheric phenomena that take place within, below and above the storm clouds. Transient Luminous Events (TLE), are one type of these phenomena. They occur in the middle atmosphere, often over mesoscale convective systems (MCS) with intense convection and horizontally extensive layered clouds, but they can also originate from smaller-scale storms. Despite intensive research, many characteristics of TLE-producing storms are not fully described. Therefore, based on optical observations of TLEs, two convective storms were selected (an MCS crossing central Europe and a relatively small convective storm over Domažlice) and their characteristics were described using satellite data.

Intercomparison of Boundary Layer and Mixing Layer Height from Models and Ground-based Measurement

Julaha K., Ždímal V., and Zíková N.

Abstract. Boundary layer, the lowermost layer of Earth's surface, is considered as a key parameter in vertical transport of mass, energy, and moisture. The Convective Boundary layer characterized by vigorous turbulence tends to disperse and mix emitted pollutants and is also known as Mixing Layer. There is a lack of studies on the reliability of boundary/mixing layer retrievals from reanalysis models, which are considered relatively well to capture the general pattern of the daily cycles, particularly for remote regions. In this work, we compared ERA5 boundary layer and HYSPLIT model based on GFS, GDAS, and Reanalysis datasets on mixing layer height to the ground-based ceilometer data for the National Atmospheric Observatory Košetice. We found that the boundary layer height tends to be lower in ERA5 and timing for the daily peak also appears to differ as compared to the ceilometer boundary layer data. In contrast, the ERA5 boundary layer was found to agree well with the mixing layer height obtained from the ceilometer. When comparing the HYSPLIT results, GFS and GDAS observations were found to agree well with ceilometer data while Reanalysis underestimated mixing layer height throughout the year.

Impact in Ionospheric Dynamics During SSW — A Case Study

Ramatheerthan S. K.*, *Lastovicka J., and Kozubek M.

Abstract. Sudden Stratospheric Warming (SSW) refers to the sudden warming in the wintertime polar stratosphere preceded by the changes in the middle atmospheric circulations. Literature suggests there will be a rise in temperature of 50 K within one week or two. The changes in the circulations attribute to the non-linear interaction of the planetary waves with the mean flow. The popular definition of SSW by the World Meteorological Organisation (WMO) defines SSW at 10 hPa and 60-degree N/S poleward. However, recent definitions count more SSWs compared to the standard WMO definition. We analyzed the meteorological aspects of 2005–2006 and 2013–2014 wintertime stratospheric warming using the reanalysis data in this investigation. The study uses warming rate as a threshold and variations in geopotential values as two necessary criteria to identify the significant warming period. The variations in ionospheric parameters are studied during the selected years' prewarming, warming, and post-warming periods.

Magnitude of Internal Climate Variability Based on Pre-industrial CMIP6 Models over Central Europe

***Randriatsara H. H. R. H.* and Holtanova E.**

Abstract. Understanding the nature of the Internal Climate Variability (ICV) as inherent to the Earth's climate system is crucial for global and regional climate models (GCMs and RCMs, respectively), since its existence is inevitable in all-time series of any meteorological variable. This obviously makes the ICV a source of uncertainties in climate models' outputs. Thus, the present research aims to assess the ICV magnitude from the pre-industrial simulations over central Europe, by computing the standard deviation and Inter-quartile-range. The results show that all the models depict the annual cycle of mean air temperature over the study area, while they perform differently throughout the yearly time-series. The standard deviation's annual cycle shows remarkable dissimilarities between the models compared to the seasonal cycle, where most of the models show closer agreement with each other. The inter-quartile-range analysis displays almost the same pattern as the standard deviation. The models show larger magnitudes' spread from each other during the annual cycle analysis, while the seasonal one depicts highest values during MAM and lowest during the JJA.

Data Processing of Air Temperature and Precipitation Series in Ghana

***Yamoah K. K.*, Štěpánek P., and Farda A.**

Abstract. The basis of climatology is the availability of reliable observation data. With recent climatic changes, one must uphold the relevance of quality control and homogenization prior to any data analysis since these results are used to evaluate the impact of climate change on various socio-economic sectors to implement adaptation measures accordingly. This study presents a step-by-step guide for processing daily precipitation and air temperature data in Ghana using multiple statistical tests and reference series.

Recursion Relations for One-loop Goldstone Boson Amplitudes

***Bartsch C.**, Kampf K., and Trnka J.*

Abstract. In recent years modern amplitude methods have been successfully applied to study so-called exceptional scalar effective field theories. The non-linear sigma model (NLSM) describing the dynamics of Goldstone bosons is a prime example of this class. A hallmark feature of the NLSM is that tree-level scattering amplitudes are uniquely fixed from consistent factorization and their soft behavior (Adler zero). As a consequence, the tree-level S-Matrix can be recursively computed up to any number of external particles. This is known as the soft bootstrap. The present contribution is concerned with the extension of these recursive techniques to the 1-loop integrand in the NLSM. At loop-level we find that the integrand is no longer unambiguously determined by its unitarity cuts and soft limits. To establish uniqueness we propose an extended softness criterion for the single-cuts of the integrand, leading to the definition of the so-called soft integrand for the NLSM. This object exhibits the Adler Zero on all external lines and is suitable for on-shell recursion to all multiplicities.

Alignment Studies and Framework at Belle II

Dhayal R.

Abstract. Belle Il is a new generation B factory experiment at the SuperKEKB collider that aims to collect 50 times more data than its predecessor Belle. It searches for new physics by measuring B meson, charm hadron, or tau lepton decays with high precision. To achieve this, a high vertex resolution is needed, requiring accurate alignment of the vertex detector. This talk will introduce the Belle II, including its aim, and discusses the alignment algorithm for sensor position and surface deformations.

Study of Kaon Decay to Three Charged Pions and a Photon at NA62 Experiment

Hives Z.

Abstract. NA62 is a particle physics experiment located on the Super Proton Synchrotron at CERN. It was designed to study rare kaon decays. In this presentation we will focus on the decay of charged kaon into 3 charged pions and a photon. The theoretical prediction of its branching fraction, calculated by the means of chiral perturbation theory, is at the level of 10^{-5}. We will discuss the experimental setup, the analysis technique, and its state and show some preliminary results.

Search for Heavy Higgs Boson

Chauhan C. and Berta P.

Abstract. The Standard model (SM) of Physics faces various limitations including the neutrino masses, flavor-changing neutral currents, and the lack of dark matter candidates. One of the possible solutions to these issues is the extension of the SM by introducing an additional Higgs doublet. This analysis aims to search for a scalar or pseudo-scalar heavy Higgs boson (H/A) in an association with a pair of top quarks in proton-proton collisions. The Higgs Boson further decays into a pair of top quarks leading to the production of four top quarks at a centre-of-mass energy of 13 TeV collected by the ATLAS detector at the Large Hadron Collider. In the final state, events containing exactly one or two oppositely charged leptons are considered. This talk will present the state-of-the-art in the study of four-top-quark research, along with my preliminary work. It includes the performance of two powerful multivariate classifiers (Graph Neural Network and Boosted Decision Trees) used for signal extraction against the background and study of Profile likelihood fits performed using a statistical tool, providing insights into the statistical significance and precision of the results obtained.

General Fake-factor Method for the Fake-tau Background Estimate with the ATLAS Experiment at CERN

Martinovicová G.

Abstract. The tau-leptons are the important final-state components, not only in the Standard Model processes but also in the processes beyond the Standard Model studied at the ATLAS experiment at CERN. Jets naturally fake hadronically decaying tau leptons, so estimating such a fake-tau background is necessary. The Fake Factor method uses a correction factor, called fake factor (FF), measured from the data, and applied to the data to estimate the fake-tau background in a given signal region. One of the complications is that FF differs for tau candidates faked by jets initiated from quarks or gluons and thus must be measured in the control region with the same fraction of quark jets as in the signal region. This talk will introduce the solution to this problem — the general FF method.

Out-of-time-order Correlators

Novotný J.

Abstract. Out-of-Time Order Correlators, OTOCs for short, turned out to be a helpful tool for studying chaos in quantum systems. Short-time behavior of OTOCs has been linked to the classical Lyapunov exponent (rate of separation of close classical trajectories, the so-called Butterfly effect). Their long-time behavior hints at the amount of chaos in the system. The universality of OTOCs stems from their applicability to general quantum systems, such as spin chains, many-body systems, and black holes. This presentation briefly introduces OTOCs and their application in studying quantum many-body systems.

Forward Jets at the LHC: A Way to Probe Into the Heart of the Quark Gluon Plasma

Pauwels F. J. M.

Abstract. Heavy ion collisions have been of interest in the particle physics community because of the discovery of a new state of matter which arises from them. This state of matter, the Quark-Gluon plasma, is composed of quarks and gluons which are freed from nucleons. Although the first experimental confirmation of this new state of matter was in the year 2000, there are still unanswered questions surrounding it. One of the questions relates to the production of jets. Jets are clusters of particles that arise as a result of a hard scattering event. Due to the nature of quark-gluon plasma as a strongly interacting medium, color-charged particles (such as those arising from the hard scattering event) lose a part of their energy to in-medium gluon radiation. This can be quantified by evaluating the ratio of the jet yields obtained from heavy ion collisions and those obtained from proton-proton collisions which define the so-called nuclear modification factor, Raa. This talk will provide a background on hadron collider physics, with a focus on heavy-ion collisions in particular and will discuss the progress of the calculation of the nuclear modification factor for forward jets.

Application of Bayesian Statistics to the Sector of Decay Constants in Three-flavour ChPT

Říha J.* and *Kolesár M.

Abstract. The sector of decay constants of the octet of light pseudoscalar mesons in the framework of “resumed” SU(3) chiral perturbation theory is investigated. A theoretical prediction for the decay constant of eta-meson is compared to a range of available determinations. Compatibility of these determinations with the latest fits of the SU(3) low energy coupling constants is discussed. Using a Bayesian statistical approach, constraints on the low energy coupling constants Lr4 and Lr5, as well as higher-order remainders to the kaon and eta meson decay constants, are extracted from the most recent experimental and lattice QCD inputs for the values of the decay constants.

Geometry of Quantum States

Střeleček J.

Abstract. The geometrical structure of Quantum State Manifolds of parametric Hamiltonian systems has implications in many fields, such as the theory of Phase transitions or in the decohering quantum state driving. However, its precise meaning remains unknown. Our research aims on explaining the physical meaning of this geometrical structure, especially on the Fubini-Study metric. As a numerical model, we utilize a fully-connected qubit model, a special form of a Lipkin–Meshkov–Glick model, for which the quantum phase transitions are well observed.

Study of Four-top-quark Production with the ATLAS Detector

Timoshyn D.

Abstract. The production of four top quarks (tttt) is predicted to occur very rarely in the standard model (SM) of particle physics and varies greatly for the beyond SM (BSM) physics. Recent results by ATLAS and CMS show measured production cross-sections for proton-proton (pp) collisions at 13 TeV centre-of-mass energy, are 22.5 fb and 17.9 fb respectively, which are consistent in 1.7 and 1.1 standard deviations with SM predicted result at next leading order (NLO) logarithmic accuracy of 13.4 fb. The all-hadronic decay mode of the tttt is not considered in any current analysis by ATLAS and boosted decision trees are used to separate signal from QCD and backgrounds in CMS, with a place for future graph neural network implementation. In this work I demonstrate the state of the art measurements of tttt production and searches for new physics in BSM with tttt final states. I also present preliminary studies of identification of all-hadronic tttt events.

Introduction to the Complete Normal Ordering

Tynianskaia V.

Abstract. Normal ordering is a standard prescription in Quantum Field Theory enabling an elimination of tadpole diagrams in the free theory. In the fully interacting theory, they are no longer completely canceled by it. In addition, the procedure may also break the gauge invariance or shift the theory from its true minimum. Ellis & al. proposed its generalization, Complete normal ordering, whose employment yields the expansion around the true vacuum, and the complete cancellation of all cephalopod diagrams. Here, we introduce the procedure in detail and demonstrate it in some simple examples.

Studies of Charmonia and Jet Correlations at the LHC

Váňa P.

Abstract. Charmonia are bound states of the charm quark and anti-quark. The first discovered charmonium state was J/psi, which was discovered in 1974. Even 50 years after its discovery, we still do not know the exact mechanism of its production. This talk will consist of two parts: First, we will briefly discuss the current models describing J/psi production. In the second part, we will discuss the current analysis of the correlations between jet production in proton-proton and lead-lead collisions at the center-of-mass energy 5.02 TeV recorded by the ATLAS Experiment in the years 2015–2018. This data is also used for the measurement of possible charged particle production enhancement in the space region around J/psi when traversing the quark-gluon plasma created in lead-lead collisions. These measurements will provide us with more details about the conditions required for the formation of charmonia in such collisions as well as the possible medium induced radiation of J/psi interacting with the quark-gluon plasma.

F-11 Mathematical and Computer Modelling

Modeling and Validation of Double-layer Capacitance of Yttria-stabilized Zirconia

***Miloš V.**, Carda M., and Bouzek K.*

Abstract. Yttria stabilized zirconia (YSZ) is a widely used electrode material in solid oxide electrochemical cells. Aim of this work is providing reliable experimental data about double-layer capacitance of YSZ and using the information to calibrate the equilibrium part of continuum physical model of YSZ. The equilibrium calibration is an important pre-step before carrying out fitting process to more complex (non-equilibrium) experiments.

Incorporating Inertial Dynamics in the Vicsek Model

***Voráč D.**, Holubec V., and Ryabov A.*

Abstract. Efficient global response in many-body systems like bird flocks and crowds requires rapid information propagation. Our study reveals the relationship between local perturbations and collective behavior in highly polarized networks described by various variants of the Vicsek model. We find that information spreads faster in the model version with orientational inertia. However, we also showed that the overdamped and inertial variants of the model share many similarities.

Implementing Technologies in Physics Classroom: Teacher's Experience

Babayeva M.

Abstract. In this work, we present a pilot study on the implementaof tion didactical materials on the topic of Waves and sound propagation and usage of technologies in Physics classroom. In particular, the current work focuses on teacher's opinion and impressions on the materials and experimental setup. In the scope of pilot project, we used Arduino and LEGO Education. We discuss advantages and disadvantages of both tools from teacher's perspective and preliminary results of the project.

Students in the Role of Teachers

Ceháková L.

Abstract. Some of the university departments in Czech Republic providing education of future physics teachers deal with situation of increasing number of students who are teaching on their own on lower secondary or upper secondary schools during their daily studies (additionally to their mandatory teaching practise), the so-called students-teachers. In this contribution, partial results of the mapping of students-teachers' phenomenon in the Czech environment are presented with the introduction to further research on the motivation of these students to start teaching during own studies and their gained experience. To map this phenomena of students-teachers an online questionnaire was prepared and distributed among students of physics education.

The Use of Stories in Science Education — A Search for Research Methods and Their Effectiveness

Dolezalova J.

Abstract. A lot of teachers use stories, as they help to motivate and engage children and simplify difficult concepts. However, the efficacy of using stories in science classes, particularly physics, remains unclear. This contribution aims to introduce various methods of studying the use of stories in science lessons, with main focus on primary schools, and their impact on learning outcomes. The contribution outlines the methodology used to search for relevant articles and presents a summary of studies related to the topic of stories in science education. The author also provides a categorization of stories, based on their use, their presentation and their form that can be useful to science education. Furthermore, the contribution offers examples of how stories can be combined with activities such as physics experiments and explores different research approaches related to the use of stories in science lessons.

Teachers' and Students' Views on Physics Textbooks

Fürstová T.

Abstract. This contribution is focused on getting feedback from students and teachers on science textbooks. A literature search was conducted to answer two questions: How are teachers' and students' views on science textbooks obtained? And what should a good science textbook look like? The search revealed the most commonly used methods for obtaining opinions on textbooks and several textbook analysis tools were found. Based on the results of the search, we started to create our own textbook evaluation tool.

Long-Term Retention of Knowledge and Experiments in Physics Education

<u>Kopriva T.</u>

Abstract. This contribution presents the literature research of two topics for my thesis. The first topic is long-term retention of academic knowledge that students learn at school which is a necessity for their future life and work. We use the same knowledge-memory-source classification as Conway et al., 1997 and use the same retention of knowledge factors that Semb and Ellis, 1994 have described. The second topic of research is the effect of experiments in physics and inquiry-based physics education on students, which shows to be very positive. A shift towards inquiry-based education is a European trend that we wish to find the long-term effects of.

Qualitative Analysis of Students' Strategies in Answering Questions Accompanying Textbook Text

<u>Krejčí A.</u> and Kekule M.

Abstract. Using eye tracking, we observed the strategies of 15 high school students while reading textbook text accompanied either by a question answered directly in it, or related to it but answered implicitly or only related in theme. We then watched their gaze plots and qualitatively compared the different strategies both groups used while viewing the material. 4 main strategies of working with the material emerged. We will also show some of the indicators of cognitive processes of students reading.

Teaching Quantum Physics on a High School Level

<u>Legerská J.</u>

Abstract. In this contribution, the first conclusions from the literature research concerning quantum physics teaching on a high school level are presented. These findings will serve as a theoretical background for design-based research aimed at developing a teaching-learning sequence on quantum physics for high school students. The primary objective is to identify current trends and approaches in quantum physics teaching together with learning content appropriate for high school students and their common misconceptions in quantum physics.

Children's Research as a Way of Supporting Cognitive Talent in Primary School Children

***Vágnerová K.* and Houfková J.**

Abstract. Well-conceived children's research can be a complex, cognitively demanding process that can significantly support the development of intellectual talent in children. In this post, we will show which children naturally choose such activities. We will also describe how research activity can be used as a tool to support the development of talent in children of younger school age and present concrete examples of the practical use of the research approach in supporting talent.

Transport Phenomena in Altermagnetic Mn_5Si_3

Baďura A.*, Beckert S., Kounta I., Michez L., Leiviskä M., Seeger R. L., Baltz V., Schmoranzerová E., Kriegner D., Šmejkal L., Sinova J., Goennenwein S. T. B., Jungwirth T., and Reichlová H.

Abstract. Collinear magnetic materials are usually categorized into ferromagnets and antiferromagnets. Traditionally, band structure spin-splitting was thought to be limited to ferromagnets only. Recently, it was discovered that certain materials, so-called altermagnets, may allow cancelling the band degeneracy in spite of the compensated magnetic order. In this talk, we will introduce the concept of altermagnetism and show experimental observations of altermagnetic behaviour in epitaxial Mn_5Si_3.

Field-dependent Magnetic Ordering Dome and Quantum Spin Fluctuations in the Natural Mineral Henmilite

***Labh A.*, Legut D., Čermák P., and Jochum J. K.**

Abstract. Quantum materials have been playing a crucial role in the development of next-generation technologies and devices including quantum computers. Such materials are usually prepared under laboratory conditions. However, some naturally occurring minerals, have also been found to feature complex magnetic ground states, such as Henmilite, or Herbertsmithite. They possess spin 1/2 Cu ions which exhibit a magnetic ground state favouring the creation of quantum fluctuations, hinting at a possible quantum spin liquid state. Henmilite $\{Ca_2Cu(OH)_4[B(OH)_4]_2\}$ is a bright blue-violet colour mineral, which has been suggested to consist of coupled two-leg ladders, where strong quantum fluctuations suppress (AF) magnetic order at low temperatures. It is an extremely rare mineral only found in the Fuka mines of Japan. In Henmilite, the B–T phase diagram has an unusual antiferromagnetic dome. DFT calculations suggest the magnetic 2-dimensionality of the material. We will present our experimental results of magnetic susceptibility, heat capacity, and thermal conductivity experiments as well as corresponding theoretical calculations for its magnetic ground structure.