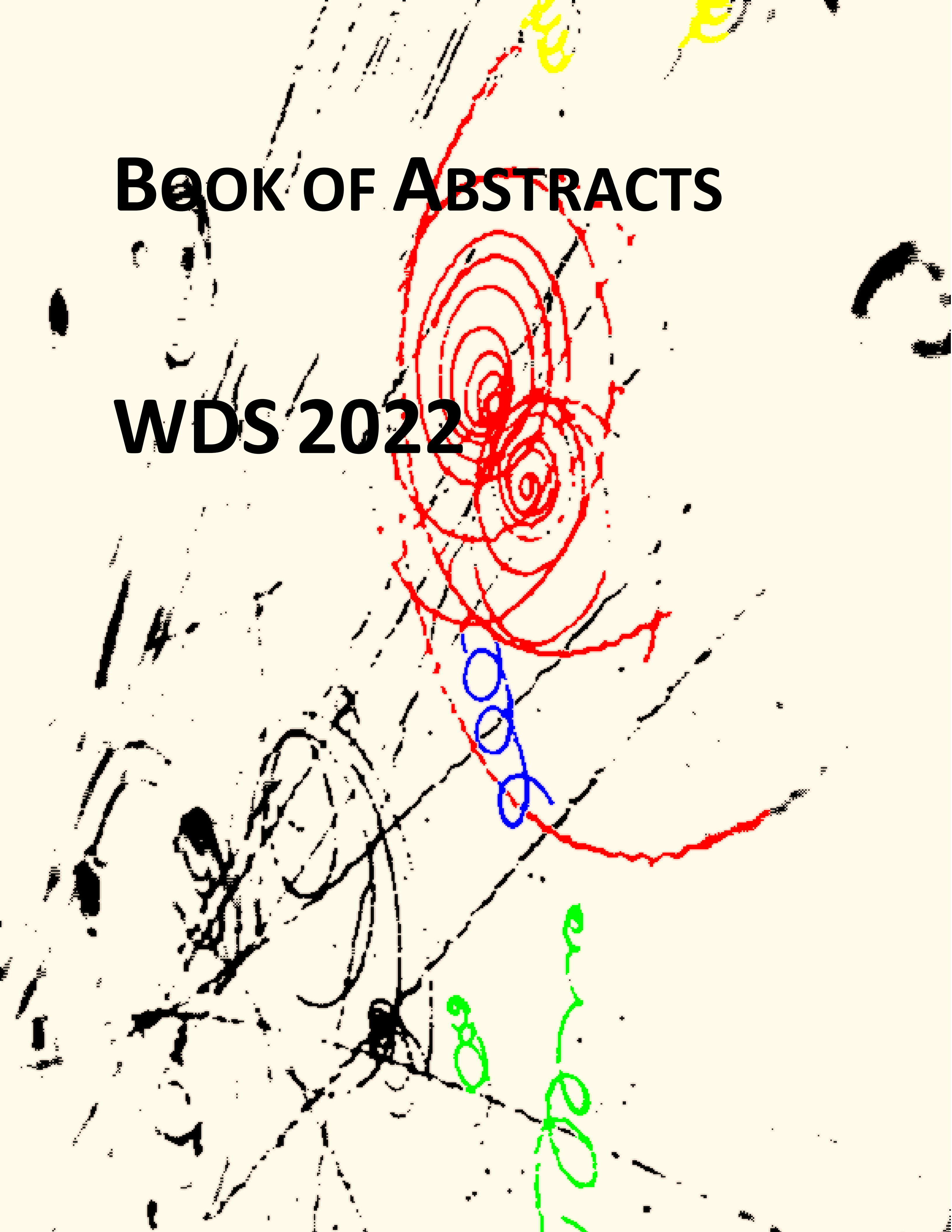
# Book of Abstracts

# WDS 2022



# BOOK OF ABSTRACTS

## Week of Doctoral Students 2022

Prague, June 7–9, 2022

# CONTENTS

Abstracts are listed alphabetically
by presenting authors in each section.

# F-1 Theoretical Physics, Astronomy and Astrophysics

### A Theory of Binary Mass Transfer

***Cehula J.***

**Abstract.** Binary mass transfer (BMT) is a common phenomenon in stellar astrophysics. It is responsible for two main formation channels of compact binaries. Namely, common envelope evolution and formation through stable BMT. Compact binaries include progenitors of gravitational wave sources detected by LIGO. By finding new ways of looking at the BMT we can constraint the formation rates of compact binaries. I will introduce new model of BMT. The new model predicts mass transfer rates which may differ by a factor of 2 compared to the standard models. This has implications for binary stability.

### Characterization of B-Supergiant Stars

***Guha S.***

**Abstract.** My study-focus is on the characterization of B-Supergiants. These objects show spectroscopic variability that has been assigned to pulsations. TESS revealed that many B-supergiants display irregular behavior of their light curves of yet unknown origin. For a selected sample, simultaneous spectroscopic observations are being acquired with the Perek telescope to investigate their pulsations and their influence on the stellar and wind parameters.

### Recombination Energy and Shock Interaction in Luminous Red Novae

***Kirilov A.**, Calderon D., and Pejcha O.*

**Abstract.** We explore shock interaction between ejecta from a dynamical merger and circumstellar material as a possible energy source in Luminous Red Novae. We aim to include the effects of recombination of hydrogen in shaping the lightcurve both due to change of opacity and the equation of state. To achieve this, we use the newly developed moving mesh radiation hydrodynamics code RJET to obtain synthetic lightcurves. I will discuss the progress made and the challenges that lay ahead.

### Schwarzschild–Bach Black Holes in the Eddington–Finkelstein Coordinates

***Knoska S.*** ***and Svarc R.***

**Abstract.** We analyze the properties of the quadratic corrections to the Einstein–Hilbert action as the natural extension of general relativity in spherically symmetric geometry in the coordinates with clear geometrical meaning. Analogously to the previous works, the exact power series solution is found, and additionally, the interpretation of the free parameters is studied, the quantification of the quadratic contribution is introduced, and the exact solution is compared to the explicit linearized one.

### Higher-Dimensional Robinson–Trautman Spacetimes Coupled to Conformally Invariant Electrodynamics

***Kokoska D.*** ***and Ortaggio M.***

**Abstract.** We present the complete family of higher-dimensional Robinson–Trautman spacetimes sourced by (aligned) conformally invariant non-linear electrodynamics with an arbitrary cosmological constant. Subsequently, some properties of a static subclass are also investigated. It contains dyonic black holes with various horizon geometries and different asymptotics. Finally, we discuss the special case of stealth solutions.

### Ultralight Dark Matter and Pulsars

***Kus P.***

**Abstract.** Dark matter (DM) can consist of very light bosons behaving as a classical field that experiences coherent oscillations. If a binary system is surrounded by DM, it could perturb the system's dynamics via both gravitational and direct interactions, leading to secular changes of orbital parameters. The secular changes could be detected in pulsar timing measurements, giving us constraints on coupling constants. This talk gives an overview of this topic and an outline of future plans.

### Improved Point Spread Function Correction for Aerosol Measurements Using Wide-field Stellar Photometry

***Negi S.*, Ebr J., and Karpov S.**

**Abstract.** When using wide-field stellar photometry to measure Vertical Aerosol Optical Depth (VAOD), we model the dependence of measured stellar fluxes on the star color and position within the field of view of the imaging system in order to control systematic uncertainties introduced through those dependencies. In wide-field imagers, the Point Spread Function (PSF) varies significantly across the instrument's field of view (FOV) as the deformation of star images increases with the distance from the center of the FOV. We use synthetic flat-field correction created through simultaneous analysis of many images, such an approach fails to account for the image-to-image changes over time. This effect is believed to be the main reason for fluctuations in the conversion factor between measured photometric flux and actual star brightness (also known as zeropoint) as determined by self-calibration scans, which is the dominant source of uncertainty for single-image VAOD measurements. We study the possibilities and limitations of using the PSF Extractor code to extract a precise PSF model from wide-field images and compare it with the actual star shape.

### Cosmological Simulations with Milgromian Dynamics

***Samaras N.*, Kroupa P., and Thies I.**

**Abstract.** Milgromian Dynamics is a law of Gravity applied to Galaxies, explaining the observed discrepancy of the Rotation Curves from a Keplerian Potential without claiming any need of exotic Dark Matter particles. Following this generalized Gravitation formalism, we are simulating the Cosmology and the Galactic interactions to test the underlining theory.

### Some Aspects of Gravity in Higher Dimensions and Kerr–Schild Spacetimes

***Ortaggio M. and Srinivasan A.***

**Abstract.** Higher dimensional gravity (HDG) has exhibited properties very different from that of four dimensions and hence has proved to be an exciting avenue of research. In the study of HDG, the Kerr–Schild (KS) class of spacetimes has played a pivotal role. This presentation will review some aspects of HDG and KS spacetimes. Also, a preliminary result pertaining to the charged KS solutions in higher dimensions will be discussed briefly.

### Shapes and Physical Properties for Ten S-type Asteroids

***Tan H. and Durech J.***

**Abstract.** Asteroid physical parameters such as thermal inertia, geometric albedo, and surface roughness, in conjunction with the shape of the body and its orientation in space, are the fundamental information for asteroids. The asteroid's shape and spin state could be reconstructed from the long-term observational data by the lightcurve inversion method. Asteroid thermophysical parameters together with its size are obtained by fitting a thermophysical model to observed infrared data. Using the convex inversion thermophysical model (CITPM) developed by Durech et al. Reference to optical data from ground-based surveys and infrared data obtained by space missions at different oppositions, we were able to constrain asteroid's physical parameters. In this study, we ran ten S-type asteroids as a pilot test, all of them have already been analyzed before, which makes them good comparison targets to confirm our method. Our results are well consistent with previous works, we provide a more realistic estimate of uncertainties of the derived parameters, and we expect to analyze thousands of asteroids in our future work.

## Search for QCD Instantons at ATLAS

***Vavricka R., Sykora T., and Schott M.***

**Abstract.** Yang–Mills gauge theories, more specifically QCD, exhibit complex phenomena not found in the baseline QED, notably the existence of countable energetically equivalent but distinct vacui. Permitting classical field solutions of pure gauge on the initial and final time slices, yet nontrivial in the bulk between; such solutions modify the path integral — instanton process — something that can potentially be observed at LHC, proofing and deepening our theoretical understanding of the field theory.

## How Many Explosions Does One Need? Quantifying Supernovae in Globular Clusters from Iron Abundance Spreads

***Wirth H., Kroupa P., Haas J., Jerabkova T., Yan Z., and Subr L.***

**Abstract.** Iron is a product of supernova (SN) explosions. In this work we create an analytical model to estimate how many SNe must have happened to explain the iron spreads observed in 55 Milky Way GCs. We also compute the time after which star formation (SF) must have ended from this number of SNe and explore, how this is affected by the choice of the stellar initial mass functions when the GCs were forming.

## F-2 PHYSICS OF PLASMA AND IONIZED MEDIA

### The Study of Hot Electrons Generated by TW Laser Radiation in Sn Foil

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

**Abstract.** The study of hot electrons is crucial in many applications, such as inertial confinement fusion and laboratory astrophysics. We present the experimental results from the Prague Asterix Laser System (PALS) to characterize hot electron distribution under the laser irradiance on a 25 um thick Sn foil in the intensity of ≈$10^{16}$ W/cm$^2$. Multi-channel electron spectrometers designed at PALS provide electron energy distribution, temperature, and total charge. In addition, plasma is characterized by measuring electron density distribution using three-frame interferometry.

### Statistical Analysis of Parameters Controlling the Magnetopause Location

*Aghabozorgi Nafchi M., Nemec F., Pi G., Nemecek Z., and Safrankova J.*

**Abstract.** Various empirical models of the magnetopause location have been proposed. They typically predict the shape and size of the magnetopause as a function of the solar wind dynamic pressure and Bz component of the interplanetary magnetic field, which are found to be the two main controlling parameters. Some other parameters, e.g., the dipole tilt angle, are sometimes further considered. In this work, we use the extensive data set consisting of nearly 50,000 magnetopause crossing encountered by the THEMIS A–E, Magion, Geotail, and Interball spacecraft to evaluate the accuracy of three widely used magnetopause models (Petrinec and Russell, 1996; Shue et al., 1997; Lin et al., 2010). We discuss several possible ways of the aberration removal and effects of solar wind parameters omitted in the models (primarily the interplanetary magnetic field orientation), demonstrating their non-negligible influence on the magnetopause location.

### Global Thermal Model of the COMPASS-U Tokamak

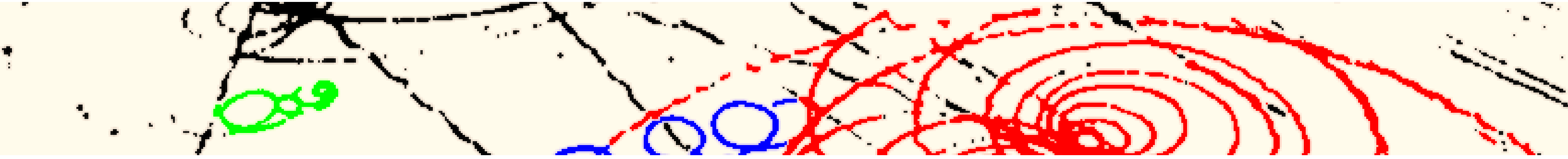
***Barton P.**, Zelda J., Prevratil J., Varju J., and Havlicek J.*

**Abstract.** Two key design features of new COMPASS Upgrade tokamak are actively heated interaction vessel (up to 500 °C) and cryogenically cooled copper coils (down to 77 K). Because of their proximity means the danger of detrimental heat fluxes, global thermal model of 1/8 of whole tokamak assembly was created. This poster presents preliminary results, including heat fluxes to cold parts, temperature distribution on hot parts and implications to development of diagnostics.

### Observing the Martian Ionospheric Plasma Depletion Events by the MAVEN and Mars Express Spacecraft

***Basuvaraj P.**, Nemec F., Nemecek Z., and Safrankova J.*

**Abstract.** *In-situ* measurements of the Martian ionosphere by the Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft revealed that the dominant ionospheric ions and thermal electrons sometimes undergo sudden depletions with an abrupt increase in the plasma temperature, known as Plasma Depletion Events (PDEs). In this study, we attempt to identify PDEs simultaneously from local and remote measurements of MAVEN and Mars Express spacecraft, respectively. Considering the time durations and spatial extents of PDEs observed by MAVEN and the trajectories of the two spacecraft, we identified 6 out of the 1177 MAVEN events as possible candidates to be observed also by Mars Express. Using MAVEN local plasma density measurements, a plausible model ionogram comprising the depleted ionospheric structure has been obtained for different Mars Express altitudes. We show that the detection of PDEs is feasible by the Mars Express radar sounding for local plasma frequencies above about 0.5 MHz.



### Electron Induced Processes on Pyridine

***Blasko J., Orszagh J., Stachova B., and Matejcik S.***

**Abstract.** The aim of this work is the experimental study of electron-induced processes such as ionization and dissociative ionization, dissociative excitation, and ionization excitation of pyridine. Using two experiments, both crossed beams one utilizing quadrupole mass spectrometry and other optical emission spectrometry, we can provide more complex study of electron-induced processes.

### Characterization of Microdischarges Generated by Pulse Electric Field

***Cibikova M., Klas M., Cermak P., and Matejcik S.***

**Abstract.** Microdischarges are discharges generated at the micrometric scale of electrode distance. Nowadays, they are used in many areas such as industrial, environmental, and biological so their characterization is an important point of interest. The objective of this work is to characterize the microdischarge breakdown voltage and emission current as a function of electrode distance and pulse electric field rate in air. To avoid the pressure effects, our measurements are performed in a vacuum system.

### Variations of Alpha Particle Parameters Across Corotating Rarefaction Regions

***Durovcova T., Safrankova J., and Nemecek Z.***

**Abstract.** A corotating rarefaction region (CRR) is formed between the slow solar wind stream and the fast stream in front of it. In our study, we focus on behavior of the second most abundant ion component, alpha particles. To determine the global profile of alpha properties across CRR at 1 AU, we perform the superposed epoch analysis of identified CRRs. Despite the expectation that the alpha relative abundance ($A_{He}$) would decrease from the beginning of the rarefaction, it corresponds to values usually observed in the fast solar wind for a large part of the CRR. Moreover, $A_{He}$ is often enhanced near the expected stream interface. Therefore, we propose that a major part of the CRR is filled by the wind from a coronal hole and discuss various scenarios that could explain the obtained profiles of alpha particle parameters across CRRs.

### Kinetic Monte Carlo Simulations of Polaronic Diffusion in Doped Hematite

***Gabriel V.**, Kocan P., Wrana D., Redondo J., and Setvin M.*

**Abstract.** Hematite (alpha-$Fe_2O_3$) is a promising material for photoelectrochemical water splitting. As observed, doping improves the chemical reaction efficiency due to enhanced mobility of polarons (electric charges coupled with lattice distortions in the crystal). We developed a kinetic Monte Carlo model to study the influence of the dopants on the kinetics of the system. Using the model, we simulated the injection and diffusion of polarons in Ti – (electron polarons) and Ni – (hole polarons) doped hematite. The study helped to interpret behavior of the polarons on the hematite (1-102) surface measured by the Kelvin Probe Force Microscopy.

### Functionalization of Polyethersulfone Film by Atmospheric-pressure Plasma Generated in O2 and N2 Atmosphere

***Ghourchi Beigi P.**, Zahedi L., Zazimal F., Vida J., Homola T., and Kovacik D.*

**Abstract.** This study presents improvements of the polyethersulfone (PS) surface properties using plasma treatment, carried out by Diffuse Coplanar Surface Barrier Discharge (DCSBD) in oxygen and nitrogen, as working gases. In this case, the most crucial disadvantages like low surface energy or problematic adherence of PES turn into a significant advantage, the enhanced adhesion. To show this improvement, we used different analyses, such as Water Contact Angle, X-ray Photoelectron Spectroscopy, Atomic Force Microscopy, and UV-VIS-NIR Spectrophotometer.

### Determination of Electron Fluxes in a Low Earth Orbit with SATRAM and Comparison to EPT Data

***Gohl S.**, Bergmann B., Kaplan M., and Nemec F.*

**Abstract.** A comparison of electron fluxes measured by the Energetic Particle Telescope (EPT) and the Space Application of Timepix Radiation Monitor (SATRAM) was conducted. Therefore, electron fluxes measured by SATRAM had to be determined. A neural network was utilized for particle identification, when applicable, substituted by a statistical approach, when not. Simulations were conducted to determine the geometric factor and other correction factors. The results show an overall good agreement with the exception of very high EPT fluxes.

## Design of Ion Trap Experiment for Studies of $H_3^+$ Rotational Relaxation

***Hernandez Alvarez O.E.**, Palacky J., Vanko E., Rednyk S., Roucka S, Dohnal P., Plasil R., and Glosik J.*

**Abstract.** We present the design of an ion trap experiment for studying nuclear-spin-changing collisions between $H_3^+$ and $H_2$. We will use action spectroscopy to observe the rotational population of the trapped $H_3^+$ ions and to measure the rate coefficients of the nuclear-spin-changing processes. The experiment is designed with the help of a state-to-state kinetic model of the trapped ions.

## One-Year Analysis of Dust Detection Using Monopole and Dipole Electric Field Antennas

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

**Abstract.** The Langmuir Probe and Waves (LPW) instrument onboard Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft detects electric field signals in dipole and monopole configuration using two long identical stacer booms. This technique has been previously applied to detect dust impacts in space for several decades. The major advantage of this method is that entire spacecraft surface acts as a detector. We present a preliminary statistical analysis of 1-year (2015) observations of dust impacts by the Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft. Out of all the modes we use the medium frequency burst mode, the data covers 62.5 milliseconds using 4096 measured points which gives us a sampling frequency of 66.67 kHz. First, the algorithm selected events for which the derivation exceeded a threshold value. In total we find 9848 events which compose of solitary waves and the most probable candidates for dust impacts. The shape of dust impacts varies with the instrument operating mode. In the data analysis it is very challenging to completely distinguish dust impact signals from the solitary waves.

### Direct Characterization of Ultra-Intense Focused Laser Beams Utilizing Ablative Imprints

***Jelinek S.**, Chalupsky. J, Burian T., Dudzak R., Hajkova V., Vozda V., Zastrau U., Makita M., Nakatsutsumi M., and Juha L.*

**Abstract.** Characterization of the fluence distribution in the focus of ultra-high intensity laser beam is important for investigating laser-plasma interactions. We studied the fluence distribution in the laser beam focus utilizing the direct method of ablative imprints. The method is based on creating cross-sections at varied levels of the fluence distribution. We present experimental results obtained at two distinct ultra-high intensity laser facilities and discuss use of ablative imprints method.

### Measurements of Titanium Deposition Rate and Ionization Fraction in HiPIMS Plasma with the Magnetic Quartz Micro-Balance Probe

***Kapran A.**, Hubicka Z., Antunes V., and Minea T.*

**Abstract.** This study is addressed to the searching of optimal conditions for a high-power impulse magnetron sputtering (HiPIMS) sputtering in a non-reactive mode. Since the degree of magnetron balancing and the geometry of the magnetic field above the target surface are known as the crucial factors influencing the thin films deposition, we focused on the detailed investigation of the effect of magnetron configurations on the HiPIMS pulse of different lengths. Three magnetron configurations have been chosen for this study: a strong balanced magnetron, which is commonly in use for HiPIMS; a balanced magnetron with the weak magnetic field and the unbalanced (II-type) magnetron. The HiPIMS was operated in a fixed peak current mode with the constant frequency and varied pulse on-time. The obtained results revealed a significant difference in the trends of the deposition rate and ionized flux fraction reaching the substrate in dependence of the degree of balancing of the magnetron. The strong effect of the pulse length decreasing has been observed. The ions flux fraction and total deposited flux were measured with the magnetic quartz micro-balance (QCM) probe.

## Precise Determination of $C_2H_2$ Reactant Density for 22-pole Radiofrequency Trap Experiment

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

**Abstract.** In conjunction with the study of the reaction between $O^-$ and $C_2H_2$ performed using 22-pole RF ion traps, a relative amount of $C_2H_2$ in a commercial mixture of $C_2H_2$ and helium was determined. A continuous wave Cavity Ring-Down Spectroscopy technique was employed to monitor several absorption lines of $H_{12}C_{12}CH$ and $H_{13}C_{12}CH$. The obtained results enabled to substantially lower the systematic error of the value of the measured rate coefficient for the aforementioned reaction.

## Electromagnetic Radiation of Cloud-to-ground Lightning Flashes Detected by Broadband Receiver BLESKA and Narrowband SAETTA Stations

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

**Abstract.** All evolution stages of cloud-to-ground (CG) lightning flashes generate electromagnetic radiation, which can be used for their investigation. We combine measurements of the broadband receiver BLESKA and the lightning mapping array network SAETTA, capable of detecting sources of narrowband very high frequency radiation. We investigate 17 positive (+CG) and 20 negative (–CG) strokes detected in the Mediterranean region during autumn 2015 with an aim to compare the post-stroke incloud processes.

## Fast Field Line Mapping for Tomography Contribution Matrix Calculation

***Kripner L.** and Cavalier J.*

**Abstract.** Building of contribution matrix is time demanding operation during tomography reconstruction. The standard calculation requires field line tracing and is expensive to calculate. In this contribution, we present a method that uses mapping to so-called straight field line coordinates and enables mapping along the field line in constant time. Consequently, the new approach allows rapidly speeding up the tomography contribution matrix construction and allows increasing the resolution of the matrix.

## Characterization of EUV Laser Beams by Ablation Imprints in PMMA Created at Varied Target-focus Distances

***Kuglerova Z.**, Chalupsky J., Vozda V., Vysin L., Juha L., Fekete L., Rocca J.J., Menoni C., and Rush L.*

**Abstract.** Proper diagnostics of intense non-Gaussian EUV/x-ray laser beams is necessary for experimental data evaluation. The Nonlinear response function recovery (NoReFry) algorithm is a useful tool for such diagnostics exploiting the AFM morphology of ablated craters in PMMA created by a laser beam at varied fluences of laser pulses. We present an extended NoReFry 2.0 algorithm combining the fluence scan method with the through focus z-scan — varied fluences at different sample-to-focus distances.

## Study of Ion Reactions with Water Molecules in Gaseous Phase for Trace Gas Analysis

***Lacko M.** and Spanel P.*

**Abstract.** Chemical ionization mass spectrometry (CI-MS) is a powerful analytical technique, capable to detect trace levels of organic molecules diluted in air samples in a real time. Processes leading to ionization of organic molecules, necessary for their detection and identification, are however often strongly affected by presence of water vapors in form of sample humidity. In the present work we studied influence of water vapors on ion chemistry and, subsequently, the respective influence on sensitivity and selectivity of CI-MS techniques. Studies were carried out using several soft chemical ionization mass spectrometry instruments, including Selected Ion Flow Tube Mass Spectrometry (SIFT-MS), Proton Transfer Reaction Mass Spectrometry (PTR-MS) and Selected Ion Flow-Drift Tube Mass Spectrometry (SIFDT-MS). Experimental studies were also supplemented by theoretical calculation of proposed ion chemistry using developed Kinetic of Ion-Molecular Interaction simulator (KIMI). In this thesis, we present study of formaldehyde, glyoxal and phthalates ion chemistry with $H_3O^+$, $NO^+$ and $O_2^+$ reagent ions, focusing on secondary reactions with water vapors.

**Development of Electron-Ion Point Paul Trap**

***Lausti N.V., Antony A., Rendek A., and Hejduk M.***

**Abstract.** Paul traps, based on oscillating electric field, are a common way to trap ions. Recently, also electrons have been trapped with a Paul trap. Their simultaneous trapping with ions could be used to form ultra-cold electron–ion plasma. Electron trapping can also have important applications. We present a model of point Paul trap with only one electrode ring, divided to eight electrodes, and able to trap ions and electrons. Phase shifts are reduced with electrode division and symmetric feeding lines. The trap has a layered structure, and can be manufactured using laser micro-fabrication.

**Plasma Position Reconstruction Using the COMPASS-U Magnetic Diagnostics**

***Markovic T., Torres A., Fridrich D., Imrisek M., Jaulmes F., and Balner V.***

**Abstract.** To prevent the high heat fluxes from plasma to tokamak first wall the position of the plasma separatrix needs to be known within a certain accuracy to be used as an input for the plasma position feedback system. This work uses synthetic magnetic signals as an input into the EFIT plasma equilibrium reconstruction code to demonstrate that the COMPASS-U magnetic sensors can provide position and shape of the plasma separatrix within the precision specified by the machine requirements.

**Ion Mobility Spectrometry Diagnostics of $NO_2$ Generated in kHz Driven DBD Plasma Jet in Argon**

***Matas E., Moravsky L., and Matejcik S.***

**Abstract.** Reactive oxygen or nitrogen species (RONS) like as $O_3$, OH radicals, $NO_2$, $H_2O_2$ and other can be generated by Ar plasma jet. There are several standard methods for diagnosing them, such as FTIR spectroscopy or chemical gas sensors. In this work, we show a new possibility $NO_X$ detection using ion mobility spectrometry (IMS). The $NO_2$ concentration was determined by $NO_2$-current signal. The detection limit was set at 200 parts per billion (ppb).

## Halo Currents Characterization at the COMPASS Tokamak

***Matveeva E.**, Havlicek J., Artola F.J., Yanovskiy V., Havranek A., Adamek J., Gerardin J., Imrisek M., Weinzettl V., Hronova O., and Panek R.*

**Abstract.** One of the major disruption consequences in tokamaks is formation of so-called halo currents. They are flowing along the open magnetic field lines in the plasma and closing their path through the vacuum vessel. Halo currents give rise to the forces acting on the vacuum vessel and it is important to determine their magnitudes and poloidal extension. This work presents halo currents measurements by magnetic coils. It contributes to the hypothesis that halo density might be limited by ion saturation current.

## Optical Emission Diagnostic Study of He+$N_2$+$CO_2$ Plasma in Non-Segmented Cylindrical Magnetron

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

**Abstract.** We measured plasma parameters (excitation temperature, electron density, rotational and vibrational temperature) in non-segmented cylindrical cathode magnetron by an optical emission spectroscopy (OES). Admixture of He+$N_2$+$CO_2$ gases in ratios of 3:2:1 is deployed for plasma study through OES diagnostics in a regime of the magnetic field. The objective of study is to understand effect of the gas mixture He+$N_2$+$CO_2$ on plasma parameters. The rotational temperature ($T_{rot}$), vibrational temperature ($T_{vib}$), and electron density ($n_e$) were calculated by using spectral lines which were obtained through OES. This work also aims to investigate the validity of the excitation temperature ($T_{exc}$) by an OES as an alternative to the electron temperature ($T_e$). The whole results of emission spectroscopy in a mixture of He+$N_2$+$CO_2$ being analyzed by changing magnetic field (in Tesla), current (in mA), pressure (Pa), keeping flow rate (sccm) constant.
Keywords: Optical emission spectroscopy, Non-segmented cylindrical cathode magnetron, He+$N_2$+$CO_2$ plasma

### Preparation of Ni-containing Oxides Films by Hollow Cathode

***Naiko I., Kudrna P., Hubicka Z., Cada M., and Ostapenko A.***

**Abstract.** Using hollow cathode technique often provides a high deposition rate of the material (for example, in comparison with magnetron sputtering), as well as to sputter of composite materials. At least, a few articles reported successful use of hollow cathode sputtering to obtain metal oxide thin films ($Co_3O_4$, ZnO, $Zn_xSn_yO$, $Cd_xSn_yO$, $In_2O_3$, $TiO_2$). Thereby, we are curious about the use of hollow cathode for preparing Ni-contained films for the oxidation of volatile organic pollutants.

### Calculations of Structures and Energetics of Organic Ions Relevant to Gas Phase Ion Chemistry

***Omezzine Gnioua M. and Spanel P.***

**Abstract.** To understand structures and energetics of organic ions relevant to gas phase ion chemistry, quantum chemistry calculations were performed using ORCA software. Molecular geometries of a range of neutral volatile organic compound molecules and corresponding ions were optimized using the B3LYP DFT. Then the normal mode vibrational frequencies of the neutral molecules and of the several different ion structures were determined. The total enthalpies of the neutral molecules and ions resulting from protonation, addition of $H_3O^+$ and addition of $NH_4^+$ were thus calculated for the standard temperature and pressure. The calculations were performed for several feasible structures of each of the ions. For all neutral molecules, the dipole moments and polarizabilities were also calculated as needed to determine the collisional ion–molecule reaction rate coefficients.

### Temporal Limit of Langmuir Probe Measurement in Electron Saturation Region Around 133 Pa

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

**Abstract.** Langmuir probes are one of the most common diagnostic tools of plasma. They are used to determine various plasma parameters which are crucial for correct predictions of plasma behavior. In certain conditions there is a need to do very fast measurements and the temporal limit of the probe measurement can be a limited factor. It can be a study of a rapidly evolving phenomenon or when only limited time exposure of the probe to plasma is allowed. Finding the limit of the probe dynamic requires information from probe surroundings on the microscopic level and computational methods are well suited for this task. The simulated time evolutions of current, potential around probe and size of the probe sheath are used to obtain the characteristic times of the plasma stabilization after potential changes on the probe.

### Spectral Analysis for Four Types of Interplanetary Shocks

***Park B.*, Pitna A., Safrankova J., and Nemecek Z.**

**Abstract.** The interaction between interplanetary (IP) shocks and solar wind has been studied for the understanding of energy dissipation mechanisms within collisionless plasmas. Compared to the study of the interaction with fast shocks, less attention has been directed to the interaction with different types of IP shocks including slow mode shocks. IP shocks from 1995 to 2015 were analyzed from Wind spacecraft at 1AU. Spectral analysis of magnetic fluctuation by continuous wavelet transform was employed for four different types of IP shocks (i.e. fast forwards, fast reverse, slow forwards and slow reverse) in order to estimate the enhancement of the fluctuation from upstream to downstream plasmas and the change of spectral indices in inertial and kinetic range. Preliminary results indicated that the enhancements of magnetic fluctuation for both slow forwards and reverse shocks were of the order of one on average. Additionally, the shape of upstream and downstream spectra for these slow shocks did not show a significant difference, whereas steeper downstream spectra within inertial range were obtained in the fast shocks.

### Effect of Magnetic Islands Rotation on Disruptions in Presence of Error Field

***Peterka M.*, *Seidl J., Markovic T., Grover O., Casolari A., Bilkova P., and Panek R.***

**Abstract.** Locking of magnetic islands (LM) and disruptions after the L–H transition in presence of magnetic error field (EF) has been observed in COMPASS experiments for several years. However, the responsible mechanism behind and criteria for its occurrence remain to be understood. In this work, we investigate a possible explanation by the critical EF for the onset of LM being dependent on the frequency of rotation of magnetic islands, as reported earlier in COMPASS-D when operated by CCFE, UK.

### State-selective Recombination Studies of H3+ by a Stationary Afterglow Experiment at Charles University, Prague

***Saito S.*, *Dohnal P., Uvarova L., Plasil R., Roucka S., and Glosik J.***

**Abstract.** We are interested in the state-specific recombination rate coefficient of para-/ortho-$H_3^+$ in the afterglow plasmas at 30 K. Under such a low temperature, only two lowest rotational states of H3+ are populated. The ortho to para ratio of feeded H2 gas controls the population distribution.

### Development of an Ion-neutral Merging Beam Experiment at Rikkyo University, Tokyo

***Saito S.*, *Iizawa M., Kawakami G., Shiina Y., and Nakano Y.***

**Abstract.** The merged-beam experiments make possible the collision of particles under 1 eV at the center-of-mass system. To be reported are also the details of the simulations and progress of developing the apparatus.

**Foreshock Wave Activity Closer to the Dayside Bow Shock: Statistical Study**

***Salohub A.**, Safrankova J., Nemecek Z., Nemec F., and Pi G.*

**Abstract.** In our previous statistical study of ULF fluctuations near the Moon connected to the foreshock, we found that these fluctuations can be characterized as a mixture of transverse and compressional wave modes with different properties at both locations. Our investigations reveal that the growth rate of waves depends on their mode being larger for compressive variations of the magnetic field strength and plasma density than for variations of magnetic field components. Here, we compare the behavior of fluctuations around the Moon with the waves observed closer to the bow shock. We selected observations in the dayside foreshock between the bow shock and 30 RE. Based on statistical studies from the THEMIS spacecraft, we discuss their properties, occurrence rates and a relation to solar wind and foreshock conditions. We conclude that compressional fluctuations are stronger in the quasi-perpendicular shock than in the quasi-parallel shock.

**Recombination of Positive Molecular Ions in Neon or Helium Buffered Afterglow Plasmas**

***Shapko D.**, Dohnal P., Uvarova L., Kassayova M., Roucka S., Plasil R., and Glosik J.*

**Abstract.** The Cryogenic Stationary Afterglow apparatus with near-infrared Cavity Ring-Down absorption Spectrometer (Cryo-SA-CRDS) is highly precise experimental setup for measurement of electron–ion recombination processes in plasmas in the temperature range of 30–300 K. For the direct measurement of electron number density decay microwave diagnostics is utilized. The electrons — positive molecular ions recombination studies will be presented for several species by using neon or helium as ambient gases for afterglow plasmas.

### Fluorescence of Neutral Fragments of Acetone

***Stachova B., Orszagh J., Blasko J., and Matejcik S.***

**Abstract.** Optical emission spectroscopy was used to study electron induced fluorescence of acetone. Acetone is the simplest ketone and is an abundant compound of the interstellar medium. The emission spectrum following electron impact on acetone was studied in a crossed-beam experiment. The spectrum was measured at several electron energies within the wavelengths of 280–950 nm. The emission bands of CH (A–X), CH (B–X) and CH (C–X) along with emission lines of hydrogen's Balmer series were detected.

### Validation of Divertor Spectroscopy Methods with SOLPS and Raysect & Cherab Framework

***Tomes M., Giroud C., and Seidl J.***

**Abstract.** The presentation sums up the effort to utilize spectroscopic measurements to infer divertor concentration of the seeding gas in high-performance scenarios. Provided transport simulations performed with SOLPS code are used to generate forward models of diagnostic signals with Raysect & Cherab framework. These are then used to design the analysis method which provides the best estimates of concentration, its uncertainties and limitations.

### Fabrication of Dye-sensitized Solar Cell, Based on Iron Sulfide Films

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

**Abstract.** Dye-sensitized Solar Cells (DSSC), based on common inexpensive materials, has been studied systematically for their industrial potential. The perspective films of iron oxide and iron sulfide obtained by hollow cathode plasma jet (HCPJ) sputtering and followed by sulfidation. DSSC cell assembly was tested. AFM, SEM, EDX and Raman spectroscopy, absorbance spectra of films presented. Keywords: hollow cathode plasma jet, iron oxide, iron sulfide, dye-sensitized solar cell

### Plasma Diagnostics of Titanium Nitride for Plasmonic Study Generated Through Hollow Cathode Plasma Jet

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

**Abstract.** Titanium nitride (TiN), along with other transition metal nitrides, have garnered much recent interest as an alternative material for plasmonic applications like sensing, photovoltaic and optical circuitry. TiN films sputtered on different substrates can exhibit plasmonic properties continuously from several nm up to micron. This work demonstrates plasma diagnostics study of TiN plasma generated through hollow cathode plasma jet in DC and pulsed DC.

### Experimental Study of the Dissociative Recombination of $N_2^+$ Ions with Electrons at Low Temperatures

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

**Abstract.** The dissociative recombination of $N_2^+$ ions with electrons in temperature range of 150–250 K was studied because that process is important in determining the physical properties of planetary ionospheres. The Cryogenic Stationary Afterglow apparatus with the Cavity Ring-Down Spectrometer was used to observe the time evolution of the number densities of rotational and vibrational states of $N_2^+$ ions. The time resolved microwave diagnostic was utilized to measure the electron number density.

### Current State of Knowledge of $OH^-$ Role in the Interstellar Medium

***Vanko E., Rednyk S., Uvarova L., Saito S., Roucka S., Dohnal P., Glosik J., and Plasil R.***

**Abstract.** Negative ions play an important role in many environments of interstellar space. According to astrophysical models, $OH^-$ ion should be abundant in such media, but it has not yet been detected. We present the current state of the knowledge of $OH^-$ role in the interstellar space and the experimental method used for our studies. Investigations of $OH^-$ formation and destruction are already underway. We use the 22-pole RF ion trap for measurements in the temperature range from 10 K to 300 K.

## Properties of Foreshock Compressive Structures and Their Relation with Jet-like Structures in the Magnetosheath

***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 structures. These structures are carried by the solar wind flow, interact with the bow shock and penetrate downstream to the magnetosheath. The local structures of enhanced density and/or magnetic field, called plasmoids and Short Large Amplitude Magnetic Structures (SLAMS) respectively, as defined by Karlsson et al. (2015) are thought to be the source of transient dynamic pressure enhancements in the magnetosheath, the magnetosheath jets. Using measurements by the Magnetospheric Multiscale (MMS) spacecraft and high-resolution OMNI data, we present a statistical analysis of foreshock compressive structures with increased density and magnetic field. Based on our statistical analysis and previous studies, we discuss features of those structures, their properties, occurrence, evolution, and relation to the magnetosheath jets and plasmoids.

## Modification of the Surface Properties of Polystyrene Film Using Rapid Atmospheric-pressure $O_2$- and $N_2$-plasma Treatment

***Zahedi L.*, Ghourchi Beigi P., Zazimal F., Vida J., Homola T., Cernak M., and Kovacik D.**

**Abstract.** Polystyrene (PS) is a polymer with excellent optical transmission and is chemically relatively unreactive. Thus, it is ideal for products in contact with body fluids. However, like most other polymers, it is hydrophobic and tends not to adhere to other surfaces. Application of atmospheric non-thermal plasma to polystyrene surface can significantly affect the wetting without changing the bulk of the polymer. In this work, plasma treatment of PS foils was carried out by Diffuse Coplanar Surface Barrier Discharge (DCSBD) in oxygen and nitrogen working gases. Plasma-treated surfaces were analyzed by the Water Contact Angle, X-ray Photoelectron Spectroscopy, Atomic Force Microscopy, and UV-VIS-NIR Spectrophotometer.

### Mechanical Properties of Al and Fe Nanocrystalline Thin Films

***Bajtosova L.**, **Krivska B., Kralik R., Vesely J., Hanus J., Harcuba P., Yadav A., Fikar J., and Cieslar M.***

**Abstract.** Thin nanocrystalline Al and Fe based films prepared by DC magnetron sputtering were deformed *in situ* in the transmission electron microscope in tension. The mechanical properties of these films were shown to be different, in the case of Al films, deformation mechanisms based on grain boundary mechanisms were observed while the deformation of Fe films was realized via dislocation motion. The experimental results were confirmed by molecular dynamics simulations.

### *In-situ* Analysis of the Deformation Behavior in a Textured Magnesium Alloy AZ31

***Dittrich J., Drozdenko D., Harcuba P., and Minarik P.***

**Abstract.** The electron backscattered diffraction (EBSD) investigation of a rolled sheet of the magnesium alloy AZ31 revealed a strong basal texture. Sets of samples with three distinct orientations with regards to the detected texture were subjected to compressive loading inside the vacuum chamber of the scanning electron microscope. The deformation tests were interrupted at pre-selected points of interest, in which the EBSD maps of the sample surface were measured. The subsequent analysis of the obtained data, including quantification of the twinned volume fraction and detailed analysis of slip bands for individual grains provided extensive insight into the correlation of the sample texture and the evolution of preferentially activated deformation mechanisms, which dictate the materials response to mechanical loading.

### Exploration of Electronic Phenomena in Layered van der Waals Materials

***Hovancik D., Piamonteze C., Carva K., Pospisil J., and Sechovsky V.***

**Abstract.** The transition-metal trihalides $TX_3$ (T-transition metal, X-halogen) are the subject of my research. They belong to the family of two-dimensional (2D) van der Waals (vdW) magnets with high potential for spintronic and microelectronic applications. In my talk, I will focus on the physics of VI3, a vdW ferromagnet with strong magnetocrystalline anisotropy (MA) causing unusual canted collinear magnetic structures. This behavior is most likely due to a large orbital moment (OM) of V3+ ion. The non-zero OM couples the spin and the lattice via spin-orbit coupling giving rise to the single-ion magnetocrystalline anisotropy. We used X-ray magnetic circular dichroism (XMCD) as an element-specific method to determine the OM of vanadium. The results of XMCD together with the bulk magnetization behavior will be discussed.

### Mössbauer Spectroscopy of $\varepsilon$-$Fe_2O_3$ Nanoparticles under Extreme Conditions

***Krcmar O., Kohout J., Kubaniova D., Brazda P., and Prochazka V.***

**Abstract.** Iron-containing compounds are especially interesting due to their industrial and medical applications. As $^{57}Fe$ is Mossbauer active isotope, one can employ Mossbauer spectroscopy to study such materials' properties. Nowadays, properties in a wide temperature range, as well as at high pressure, are at the center of scientific interest. The temperature and pressure dependence of hyperfine parameters and synchrotron radiation diffraction were studied in the case of epsilon-$Fe_2O_3$ nanoparticles.

## Magnetic Ordering in Weakly Coupled van der Waals Ferromagnet

*Carva K. and <u>Pokhrel K.K.</u>*

**Abstract.** There is a large number of materials composed of layers coupled by weak van der Waals forces, which allow for easy layer separation and arbitrary stacking of these. These specific materials can be well described by either Heisenberg or Ising Hamiltonian with an additional complicated anisotropic contribution. It is desirable to examine the consequences of various anisotropy terms. Due to their intrinsic magneto crystalline anisotropy, several vdW magnets could be thinned down to nanoscale thickness, while still maintaining magnetism. Deeper understanding of the measured results will be possible due to ab initio calculations. Especially the unusual behavior of the magnetocrystalline anisotropy needs an interpretation that could stem from examining contributions of individual 3d orbitals and their energies. Calculations can also reveal how the pressure modifies this energetics, as well as exchange interactions responsible for magnetic order. Calculations can help interpret possible unusual transport properties due to their ability to selectively enable/disable effects that influence transport, as is the spin-orbit interaction, magnetic disorder or phonon induced displacements.

## Anisotropic Magnetoresistance in Systems with Non-collinear Magnetic Order

***Ritzinger P.***

**Abstract.** Since its discovery in 1857, the anisotropic magnetoresistance (AMR) has been in focus of many theoretical studies. They range from rather simple s-d models to quite complex ab initio calculations. Most attention has been paid to ferromagnets and recently, the scope of research on AMR is extended to include also antiferromagnets (AFMs). The interest in AFMs is mainly motivated by the fact that magnetic order can be manipulated without having a net magnetic moment and thus AFMs are excellent candidates for future spintronic devices. The main focus of our work will be the investigation of intrinsic AMR, which is due to an anisotropic Fermi surface. This is achieved by considering non-collinear magnetic order on a Kagome lattice. Magnetic moments can be arranged in many different ways on such a lattice and seemingly small changes alter the Fermi surface and transport properties. We are investigating the influence of magnetic ordering on these properties which allows to predict general features of spin texture and transport by only considering the symmetry of the underlying system. Exemplary systems are discussed in this context

## Investigation of the Dynamics of Deformation Mechanisms in Mg–Gd Alloys Using *In-situ* Experimental Methods

***Szaboova A., Mathis K., Drozdenko D., Knapek M., Farkas G., Ostapovets A., Nemeth G., and Harcuba P.***

**Abstract.** The dynamics of deformation mechanisms activated in binary Mg–Gd alloys with respect to amount of Gd was investigated with *in-situ* experimental methods. Compression test were done at room temperature with simultaneous record of acoustic emission response. The acoustic emission signal was subsequently analyzed using advanced clustering method providing information about the dominant deformation mechanisms. High speed camera was used to study the dynamics of twinning, including estimation of the velocity of twin propagation with respect to Gd concentration. Concurrent molecular dynamic simulations revealed that the presence of Gd enhances the formation of stacking faults, which hinder twin propagation as effectively as twin boundary pinning by Gd solutes. Deformation tests were repeated in a chamber of scanning electron microscope with concurrent following the microstructure development using secondary electrons and electron back-scattered diffraction in different stages of the deformation. Main goal of this measurements was to identify active slip systems during deformation.

## Novel Magnesium Alloys Designed for Aviation Applications

***Sasek S., Straska J., Minarik P., Kubasek J., and Vesely J.***

**Abstract.** Two magnesium alloys designed with an emphasis on high flammability resistance (Mg-4Y-4Gd-2Ca and Mg-2Y-2Gd-1Ca, wt. %) were processed by extrusion and subsequently comprehensively investigated. A bimodal microstructure was observed by EBSD. The size of the recrystallized grains and the degree of recrystallization strongly depended on the processing parameters. TEM secondary phase analysis revealed a large amount of Mg2Ca precipitates and a small amount of RE-containing precipitates. The developed and analyzed microstructural condition resulted in favorable mechanical properties. The studied alloys are therefore promising for the application in aerospace industry.

### Martensitic Transformation in Ti Alloys in the Language of Vectors and Matrices

***Skraban T., Seiner H., Preisler D., Kozlik J., and Strasky J.***

**Abstract.** Martensitic transformation results in peculiar properties of metallic materials. For instance, the effect of superelasticity allows achieving extreme reversible deformations; shape memory effect gives material the possibility to retrieve its former shape after plastic deformation. These properties are applicable in biomedical devices or damping materials. Our work focuses on a theoretical description of martensitic transformation via continuum theory of martensite. It allows us to describe microstructure features like twinning and martensite–austenite interfaces in given crystal structures. Continuum description of martensitic transformation is a strong instrument that suitably complements experimental results and allows us to interpret observed phenomena with greater precision. Despite the generality of this theory, our materials of interest are metastable beta Ti-Nb-Zr based alloys that have a great potential for medical use.

### Advanced *In-situ* Characterization of Novel Metallic Alloys

***Tayari T., Strasky J., Minarik P., Pesicka J., and Knapek M.***

**Abstract.** Modern advanced *in-situ* methods can reveal details on the mechanisms of plastic deformation with exceptional spatial and temporal resolution. Acoustic emission detects elastic waves generated in the material due to the activation of deformation mechanisms. Electron microscopy and ultra-high-speed imaging are able to record the dynamics and localization of these processes. In this work, these methods are applied to study novel complex metallic materials.

## Single Crystal Studied of NaMnAs — A Room Temperature Antiferromagnetic Semiconductor

***Volny J.***

**Abstract.** Antiferromagnets are increasingly coming into the spotlight for spintronics applications. Currently, the most heavily studied material of antiferromagnetic spintronic is semimetal CuMnAs, where the electrical switching of the magnetic moments' orientation has been demonstrated. However, its lack of the band gap doesn't allow for the combination of spintronic and semiconductor technologies. In this talk I will present a synthesis, experimental characterization and prospects of NaMnAs.
An above room temperature antiferromagnetic semiconductor.

## F-4 Biophysics, Chemical and Macromolecular Physics

### Simultaneous Deposition of Gas-phase Aggregated Ag and Cu Nanoparticles into Liquid PEG as a Way to Produce Plasmonic Nanofluids

*Biliak K., Nikitin D., Protsak M., Tosca M., Pleskunov P., and Choukourov A.*

**Abstract.** Nanofluids of metal nanoparticles (NPs) have been studied for a long time, and the primary methods of their preparation involved wet chemistry. This work investigates the simultaneous production of Ag and Cu NPs by a physical method of magnetron sputtering using two gas aggregation cluster sources. The NPs are subsequently deposited into a host liquid of polyethylene glycol to produce plasmonic nanofluids in which bands of localized surface plasmon resonance can be tuned by the Ag-to-Cu ratio.

### Isotopic Labeling of Microalgae: Raman Study

*Bura R., Mojzes P., Bokov M., Pilatova J., and Rosenkrancova A.*

**Abstract.** Microalgae are able to produce a number of substances such as starches, oils, proteins, carotenoids, polyphosphates, or crystalline purines directly from inorganic sources by photosynthesis. Due to their autotrophic nature, microalgae are also unique as they can synthesize complex isotopically labeled biomolecules from simple isotopically labeled inorganic substances. Confocal Raman microscopy represents one of the optical methods by which the chemical composition of microalgae can be determined *in situ*, including the effect of isotopic labeling.

### Polymer Brushes and Quartz Crystal Microbalance Method Employed in Label-Free Biosensing

*Forinova M., Lynn N.S. Jr., Pilipenco A., Visova I., Vrabcova M., Horak P., and Vasicoherova-Lisalova H.*

**Abstract.** A sufficiently rapid and sensitive method for pathogen detection without a need for sample preparation is urgently needed for POC testing. We aimed to develop such a method via investigating antifouling label-free biosensors combining i) surface chemistry based on tailored polymer brushes with ii) quartz crystal microbalance method. This combination allows us for ultra-sensitive pathogens detection in complex media without any sample treatment in a short time (<30 mins). The results are demonstrated via the detection of various pathogen types, including SARS-CoV-2 and E.coli.

## Raman Optical Activity as a Potent Tool for Studies of Mononucleotide G-quadruplexes

***Jilek S.*, Kapitan J., Kopecky V., and Profant V.**

**Abstract.** Guanosine-5´-monophosphate (5´-GMP) tends to self-associate at higher concentrations and forms regular order arrangements — G-quartets and further G-quadruplexes. These associates have been thoroughly studied and have possible applications both in bionanotechnology and medical treatment. We study 5´-GMP associates using Raman spectroscopy and its chirally sensitive variant Raman optical activity (ROA). ROA appears to be very sensitive to the aggregation process reflected in significant spectral changes.

## The Functional Pore Formation of Pro-apoptotic Proteins in Giant Unilamelar Vesicles as the Model System

***Kohutova P.*, Horvath M., Riegrova P., Hof M., and Sachl R.**

**Abstract.** Apoptosis, also known as programmed cell death, is highly regulated mechanism in which the unwanted/damaged cells are removed in response to pro-apoptotic factors. The key step in intrinsic apoptosis pathway is the permeabilization of the mitochondrial outer membrane (MOM). Many proteins participate in the apoptotic pathway. To analyze the ability of pro-apoptotic proteins (Bid and Bax) to create functional pore into MOM-like membrane, we employ model membrane system — giant unilamelar vesicles (GUVs). The lipid composition of liposomes is phosphatidylcholine (PC), phosphatidylethanolamine (PE) and cardiolipin (CL). CL is a negatively charged lipid, which plays a crucial role in binding pro-apoptotic proteins to the membrane, where Bax tends to form pores. With the help of advanced fluorescent microscopy and the technique developed in our laboratory (dual+1 FCS) we correlate Bax/Bid in-membrane oligomerization to membrane permeabilization (pore formation). By that we hope to shed light on the mechanism by which pro-apoptotic proteins induce apoptosis.

## Study of Plasma-biofilm Interaction for Bio-decontamination

***Lavrikova A., Bujdakova H., and Hensel K.***

**Abstract.** Cold plasma has proven its huge potential for surface decontamination. In this study, the effects of cold plasma streamer corona discharge on S. aureus, P. aeruginosa and E. coli biofilms are demonstrated. The biofilm decontamination effect increased with the treatment time and resulted in total inactivation of P. aeruginosa and E. coli cells inside biofilms in 120 s treatment. The loss of biofilm biomass and decreased metabolic activity suggested significant destruction of biofilms by cold plasma.

## Charge Scaling for Simulations of Biologically Relevant Species in Water

***Le-Nguyen N.-L. and Jungwirth P.***

**Abstract.** Force field molecular dynamics have proven to provide understanding of various molecular mechanisms. In many biological processes, interactions between charged moieties play a crucial role. However, current empirical force fields which are non-polarizable tend to overestimate such interactions due to the missing electronic polarization. It is, therefore, essential to fix this deficiency with a computationally inexpensive method. Electronic Continuum Correction (ECC) is a simple and physically well-justified method. It is noted that there is no unique set of charges compatible with the ECC framework. Therefore, additional and non-standardized criteria are required. This calls for a unified protocol for force field development of water, ions, peptides and proteins, lipids, sugars, and nucleic acids within the ECC framework. In this work, the specific aim to be addressed is to develop a de novo consistent and unified model of water, ions, and eventually also biomolecules molecular dynamics simulations in close contact with quantum chemical calculations and spectroscopic experiments.

### Computational Modelling of Optical Activity of G-Quadruplexes

***Para Kkadan M. S.*, Bour P., Profant V., Kessler J., Jilek S., and Barvik I.**

**Abstract.** The guanine nucleotide (G) and its derivatives are well known for their unique property to self-associate into various complexes through H-bonding and stacking interactions. For example, at higher concentrations, they form nanoscale cylindrical structures called G-quadruplexes, consisting of G-quartet disks stacked one above the other. Structural control and characterization are the major challenges in maximizing the real-world potential. Recently, profound changes in the Raman optical activity spectra upon G-association were observed. However, it is difficult to link the changes to the structure and properties. Therefore, various computational tools are employed to model and interpret the observations.

### Study of the Interaction Between Collagen and Collagenase Molecules by Optical Methods in the Presence of Various Modifiers

***Petrova A.V.*, Sergeeva I.A., Sidorova A.V., and Petrova G.P.**

**Abstract.** Dynamic Light Scattering method enable us to investigate collagen and collagenase molecules solutions in conditions close to physiological. The aim of this work is to investigate the interaction between collagen and collagenase molecules in the presence of various modifiers. The use of calcium, zinc, magnesium and chromium salts is due to the influence on the activity of the enzyme of collagenase and on the structure of collagen fibers. It was revealed that when calcium and zinc ions are added to buffer solutions of collagen and collagenase, the rate of collagen biodegradation increases 2.4 and 1.3 times, respectively. It was found that when magnesium and EDTA ions are added to solutions of collagen and collagenase, the rate of collagen biodegradation decreases by 2 and 2.6 times, respectively. Chromium ions of various salts equally affect the process of collagenolysis. In the presence of chromium ions in solutions of collagen and collagenase, the rate of protein biodegradation decreases 3.8 times, which indicates the formation of cross-links in the protein and strengthening of the protein structure.

### Zirconium Nitride Nanoparticles Prepared by Reactive Magnetron Sputtering

***Protsak M., Pleskunov P., Biliak K., Tosca M., Nikitin D., and Choukourov A.***

**Abstract.** Thin films of the IV group transition-metal nitrides possess unique properties, such as chemical stability, high melting point, and hardness, and hence are widely used in industrial sectors. This work introduces the sputter-based preparation of ZrN in the form of nanoparticles. The first experimental results on reactive dc magnetron sputtering in Ar/$N_2$ have been obtained. These are compared with Zr nanoparticles produced in Ar, with a focus set on the chemical composition and optical properties.

### Development of High-Pressure Raman and Raman Optical Activity Spectroscopies for Proteins

***Rybakova O. and Bour P.***

**Abstract.** Pressure is an interesting thermodynamical parameter that can potentially influence protein structure and function; yet the complete mechanism of the pressure effects on proteins is still unknown. Various spectroscopic methods have been used to monitor the high-pressure changes, such as NMR, Raman, IR absorption and CD. However, methods more sensitive to changes in molecular conformations, such as ROA and VCD spectroscopies have not been used at all, e.g., due to technical difficulties of these measurements. In this project, we investigate effects of high pressure (<1 GPa) on Raman and ROA spectra of small peptides in aqueous solution by performing both experimental measurements and by modelling molecular behavior and simulating the spectra by means of MD/QM. Comparison of the calculated and experimental results should provide information on pressure induced changes in proteins. Here we present the project in its current state. We comment on aspects of high-pressure Raman/ROA measurements and discuss emerging technical issues. We also present the methodology of MD/QM calculations of Raman/ROA spectra and show preliminary results.

### Large Area Exfoliation of 2D Materials on Arbitrary Substrates

***Sahu S.* and Velicky M.**

**Abstract.** Two dimensional (2D) materials provide an opportunity to explore the phenomenon taking place at the thin layer regime. Since the discovery of graphene, it was observed that the mechanical exfoliation provides cleanest and most defect free samples with an only limitation of low exfoliation yield. Recently, several groups have showed a very high yield for metal-assisted exfoliation of more than 40 crystals. However, materials on metallic substrates show the completely different optical, electrical, and electrochemical properties to those on common insulating substrates such as $SiO_2$. Hence, there is a strong motivation for the development of a method to transfer the 2D materials from metallic substrates to an arbitrary substrate. Here, we introduce a metal etching based on a three-step transfer method. Our results show that this method is more effective, reliable and less time consuming than other alternatives.
The Raman and photoluminescence spectroscopies support our method of preparing defect free large area monolayers of 2D materials.

### Anti-fouling Polymer Brushes

***Spasovova M.*, Scott Lynn W., Visova I., Houska M., Vrabcova M., Dycka F., and Lisalova H.**

**Abstract.** Anti-fouling polymer brushes (PBs), coated as a nanoscale film onto the surface of a biosensor, are commonly used for the study of molecular interactions and the study of cell behavior. Here, we use infrared spectroscopy and surface plasmon resonance spectroscopy to study the role of PBs functionalization with bioreceptors to be used for biosensing. We use mass spectroscopy to investigate the characteristics of non-specifically adsorbed (fouled) proteins on a variety of PBs and furthermore, we are developing a novel microfluidic based polymerization system for the controlled preparation of PBs. Combined, these methods provide significant information for the development of PBs with even higher anti-fouling performance and will help us elucidate the complex biomolecular interactions occurring on biosensing surfaces.

**Manufacturing and Characterization of Oligoethylene–Boron Targets for Laser-Triggered p+B Nuclear Fusion**

***<u>Tosca M.</u>, Pleskunov P., Nikitin D., Biliak K., Protsak M., and Choukourov A.***

**Abstract.** Proton boron (pB) fusion (11B + p $\rightarrow$ 3alpha + 8.7 MeV) has recently been investigated in plasmas triggered by high-power laser pulses interacting with H/B-rich targets. To optimize the reaction rate in terms of alpha particle flux, it is necessary to control the target composition and morphology. This work reviews the state of the art and shows the first results obtained using magnetron sputtering and physical vapor thermal deposition for the preparation of thin films of B and oligoethylenes.

**Single Atom Co-catalyst Dispersion on $KTaO_3$ (001) by Surface Polarity Compensation**

***Alexander A.**, Redondo J., Wrana D., Johanek V., Myslivecek J., and Setvin M.*

**Abstract.** Redox chemistry on perovskite surfaces attracts attention due to these materials' promising catalytic properties, good ability to separate electron-hole pairs in light-harvesting, and the presence of ferroelectricity in many perovskites. This work focuses on enhancing catalytic activity achieved by activating the perovskite surface with extrinsic metals. Combined STM/AFM measurement together with XPS data shows the tendency of the cobalt atoms to disperse in the form of single adatoms on the polarity uncompensated $KTaO_3$ (001) surface [1]. The interaction of cobalt with KTO surfaces was studied under various reducing and oxidizing conditions, as well as a function of temperature. This, in turn, will allow characterization of the metallic, oxide, and hydroxide phases of cobalt in dependence on the environment.
The work was supported by projects GACR 20-21727X and GAUK Primus/20/SCI/009.
[1] M. Setvin, M. Reticcioli, F. Poelzleitner et al., Science 359, 572 (2018)

## Investigation of Polycrystalline $CeO_2$/GC as an Electrode Material for Glucose Detection in Phosphate Buffer Saline

***<u>Deineko A.</u>, Kalinovych V., Mehl S. L., Matolinova I., Matolin V., and Tsud N.***

**Abstract.** We were characterizing polycrystalline $CeO_2$ prepared on GC substrate as an electrode material for glucose detection. At first, bonding of glucose to the polycrystalline $CeO_2$ film was characterized at 0 potential. For this purpose, PBS solution of glucose was drop cast on the surface of the CeO2 film at ambient conditions and then the system was characterized by surface science techniques with the application of synchrotron radiation. 1, 5, and 10 mM glucose concentrations in 1 mM PBS were used. Furthermore, the reference molecular adlayer on the $CeO_2$ film was prepared by evaporation of glucose in vacuum. The coverage, cleanliness, and changes in the chemical state of the glucose adlayer were efficiently investigated with help of photoelectron spectroscopy. We have shown that the glucose molecules deposited from the PBS solution are strongly bound to the surface of the polycrystalline CeO2 film. In particular, the saturation glucose coverage was reached after deposition of 5 and 10 mM solution with C 1s and O 1s signals 10 % lower than that for the adlayer prepared in vacuum, which accounts for the presence of the additional adsorbates as PBS components and possible impurities.

## Operando Insight into Surface Chemistry of Ceria-Based Catalysts

***<u>Dinhova T.N.</u>***

**Abstract.** Cerium oxide (ceria) based catalysts have been widely investigated, mainly for their ability to switch between $Ce^{4+}$ and $Ce^{3+}$ oxidation states, giving ceria a capability to store or provide atomic oxygen to chemical reaction. Ceria-based catalysts can be used as a catalyst by themselves or as a support for other heterogeneous catalysts. Application for these catalysts has been found in many fields, including fuel cells. In most cases, the ceria catalyst has been studied as support for precious metals. Such combinations exhibit excellent catalytic properties. However, their price causes difficulties to widely manufacture them. Therefore, there are two ways to lower their price: to reduce the amount of rare metal in the catalyst or to develop catalysts containing cheaper metals. During catalytic reactions, heterogeneous catalysts undergo structural and chemical changes, which may affect their activity, selectivity, and stability. Near-ambient pressure X-ray photoelectron spectroscopy is a technique that allows us to investigate catalysts in the presence of gases or vapors, providing information about catalyst oxidation state and reaction intermediate species that appear on the surface.

## $CeO_x$/Pt Inverse Model Electrocatalyst: Relation Between Morphology, Chemical State and Stability in Alkaline Environment

***<u>Fusek L.</u>, Kerestes J., Samal P.K., Khalakhan I., Johanek V., Lykhach Y., Libuda J., Brummel O., and Myslivecek J.***

**Abstract.** Stability and chemical state of Pt-supported ceria nanoparticles (NPs) in electrochemical environments constitute key parameters for considering the electrocatalyst performance. We investigate these parameters in a model electrocatalytic study on atomically-defined inverse model electrocatalyst of $CeO_x$(111) NPs supported on Pt(111). We showed that smaller $CeO_x$ NPs prepared at lower temperature are less stable in alkaline environment and tend to form cerium oxyhydroxide.

## Iridium-Ruthenium-based Catalyst on Sputter-Etched Membrane for Proton Exchange Membrane Water Electrolyzers

***Hrbek T.*, Kus P., Kosto Y., Rodriguez M.G., Matolin V, and Matolinova I.**

**Abstract.** We present an iridium-ruthenium-based catalyst for Proton Exchange Water Electrolyzers (PEM-WE) with low iridium loading, prepared by magnetron sputtering. We use no additional support. The sputter-etching of the PEM replaces them, creating a pronounced fiber-like structure on its surface. The prepared catalyst is tested for 1272 hours in a single-cell PEM-WE, demonstrating excellent activity and stability. We focus on stability, which is the crux of a low-iridium-loading catalyst.

## Tuning the Morphology of Sputter Deposited Platinum

***Mohandas Sandhya A.L.*, Xie X., Orsag M., Dopita M., and Khalakhan I.**

**Abstract.** Large scale deployment of PEMFC into the market is still hampered due to several shortcomings among which is the high platinum catalyst cost. Several studies have proved that magnetron sputtering, a widely used technique in the industry is a simple and fast method for scalable and cheap production of catalysts. It also provides fine control over critical parameters such as morphology and structure and is also free from undesirable surfactants hence underlines the undisputable advantage of this approach compared to existing chemical wet methods of preparation. Usually, a sputter-deposited Pt catalyst grows as a compact layer which in turn limits the mass transport of oxygen and water to the catalyst hence hindering its efficiency. In this work, we aimed to tune the morphology of sputter-deposited Pt varying the deposition pressure of sputtering thereby aiming to get Pt deposited as nanocluster assembly rather than thin films. The results showed, that sputtering pressure influenced the film morphology and high sputtering pressures are beneficial, ensuring a more electrochemical active surface.

### Rotating Rind-Disk Electrode Voltammetry: As a Tool for the Evaluation of Bi-Metallic OER Catalyst Dissolution

***Kus P., Hrbek T., and Nedumkulam H.***

**Abstract.** In this study, we used rotating ring-disk voltammetry for the evaluation of bi-metallic OER catalysts dissolution in acidic media. Oxygen evolution reaction was conducted at catalyst deposited disk in galvanostatic mode and throughout the experiment the ring electrode was kept in a potentiostatic mode at the potential which metal cations dissolved from disk during OER should reduce at the ring. By the simultaneous measurements of OER on the disk and dissolution at the ring we are trying to compare the activity and stability of Ir-Ru bi-metallic catalysts with different metal ratios.

### Step Engineering for Model Electrocatalytic Studies Using Ion Erosion

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

**Abstract.** In this study we used nanoscale engineering approach to prepare surfaces with different step densities on the same single crystal substrate using ion erosion technique. Electrochemical adsorption/desorption processes were studied as a function of step density on Pt (111) single crystal. The step density was determined using STM, XPS was employed for determining the surface chemical state. Transferring the samples prepared in UHV into electrolyte was achieved using a specially designed cell enabling sample transfer from UHV to inert atmosphere without exposing to air.

# F-6 Quantum Optics and Optoelectronics

### Study of Quantum Effects in Biomolecules Using Entangled Photons

*Baksova K. and Kloz M.*

**Abstract.** Quantum entanglement is a sort of quantum correlation. Apart from its broad usage in quantum information theory, its role in biophysics has been investigated recently. For instance, it has been shown that entangled photons can be generated by so-called spontaneous four-wave mixing performed on biomolecules. We want to study decoherence in biological systems by analyzing entangled photons generated by four-wave mixing implemented on carotenoids.

### Magneto-optical Studies of Magnons in Layered Magnetic Materials

*Dzian J.*

**Abstract.** Antiferromagnetically ordered layered materials offer generally faster magnetic dynamics than ferromagnets and high resistance to perturbative magnetic fields. This is important in spintronics where one bit of information can be transferred via spin-waves (magnons), offering low-consumption data manipulation. This talk will present several examples of semiconducting layered materials with high magnon diffusion length which exhibit promising magnonic excitations down to only few atomic layers.

### Nanosecond Fiber Front-end for Pump of the 100 TW Class High Repetition Rate OPCPA

*Eisenschreiber J., Green. J.T., Naylon J.A., Horacek M., and Tykalewicz B.*

**Abstract.** The core of the thesis will be the design and realization of a high-power OPCPA system. The source of the signal pulses will be a supercontinuum centered at 820 nm with 100 nm spectral width. The pumping of these stages is provided by second harmonic from a diode-pumped solid-state laser system seeded by 1030 nm fiber front-end. To ensure even amplification of each spectral component of the broadband pulses, control over pump pulse shape is required.

## Optimization of Laser Pulse Induced Quench Switching of Antiferromagnetic CuMnAs

***Farkas A., Surynek M., Novak V., Nemec P., Olejnik K., and Jungwirth T.***

**Abstract.** Antiferromagnetic materials opened up a new avenue of research with potential use in spintronic devices. Quenching of the antiferromagnet into high resistivity states was recently discovered in CuMnAs material. In this contribution, we provide an overview of the quenching of CuMnAs using a single excitation laser pulse. It focuses on the optimization of the response with regard to different pulse parameters and compares the response for films with varying thickness and substrate material.

## Time-resolved Photoluminescence and Transient Absorption of SiV Centers in Nanocrystalline Diamond Film

***Hamracek K., Trojanek F., Ondic L., and Maly P.***

**Abstract.** Color centers in diamonds have been intensively investigated in recent years. It is mainly due to their unique optical properties and the great application potential in quantum computing as qbits, in quantum metrology, or biotechnology as biosensors. Among others, there are several types of centers in diamond with very interesting optical properties needed for their applications. NV centers are probably the best known and understood, SiV centers are the focus of research activity nowadays. Their features include very low exciton–phonon interaction, strong zero-phonon line (ZPL) around 740 nm, relatively long carrier lifetime, and weak sensitivity to electric fields. In this contribution, we concentrate on an experimental study of photoexcited carrier dynamics in SiV centers in nanocrystalline diamond film prepared by microwave plasma-assisted chemical vapor deposition (MW CVD). SiV center density reached about $3\times10^{17}$ cm$^{-3}$.

## THz Spectroscopy in the Service of Spintronics

***Kubascik P.*** ***and Nadvornik L.***

**Abstract.** Spintronic applications can be seen in everyday life as HDD of MRAM technologies. Moving an operation frequency from GHz to THz frequencies is one of the challenges in this field. THz frequencies are not available within electric measurements, and thus THz spectroscopy must be used. This presentation brings a brief overview of both emission and transmission time-domain THz spectroscopy of spintronic phenomena (SHE, AHE, AMR...). Emphasis will be on the added value of THz experiments. Presented approaches will be illustrated in our recent projects.

## Quantum Coherent Control of Free Electron Wavefunction Using Ponderomotive Potential of Optical Fields

***Moriova K.*** ***and Kozak M.***

**Abstract.** Quantum coherent control of the free electron wavefunction can be achieved using ponderomotive potential of optical travelling wave formed by two laser pulses of different frequencies. In this contribution, we will describe this novel all-optical technique whose development can enable, for example, electron vortex beam generation. The technology of quantum coherent optical phase modulation of free electrons can bring novel possibilities for imaging and spectroscopy.

## Numerical Simulations of Photonic Structures

***Novak O.***

**Abstract.** Photonic structures play a crucial role in the advanced control of light, and therefore it is essential to precisely design its geometry as it dramatically affects its properties. The talk will be focused on Yttrium-iron-garnet photonic crystal (PhC). Three numerical methods for PhC design will be briefly introduced: Yeh Formalism, Rigorous Coupled Wave Analysis, and Finite difference Time domain (FDTD). Finally, the FDTD calculation of the concentration detector will be presented.

## Ion Gun, the Weapon for Future Spintronics

***<u>Nowak L.</u>***

**Abstract.** Precise control of magnetic properties of metallic multilayers via the interface between layers of a ferromagnet and a heavy metal with spin-orbit coupling is required by applications in spintronics. A wide range of variables affects the quality of the interface, ranging from the vast amount of deposition parameters to post-process treatment. The state-of-the-art technique of *in-situ* $Ar^+$ ion irradiation as well as optical and magneto-optical characterization of studied samples will be discussed.

## X-ray Parametric Down-conversion on III-V Semiconductor Heterostructures

***<u>Pulnova Y.</u>, Mai D., and Nejdl J.***

**Abstract.** X-ray parametric down-conversion (XPDC) is a process that converts an X-ray photon into a pair of entangled photons. We aim to measure the XPDC photons utilizing coincidence detection with several modifications that could improve the XPDC efficiency. We suggest heterostructures of III-V semiconductors as a suitable medium. We pump the heterostructure with a laser pulse to enhance the built-in Stark field, which could modify the output energy spectrum and increase the coincident count rate.

## Sensitive Method for Magneto-optical Magnetometry: Polarization Dependent ROT-MOKE

***Sadeghi Z.**, Wohlrath V., Nemec P., Schmoranzerova E., Kimak J., Kubascik P., and Ostatnicky T.*

**Abstract.** ROT-MOKE is a method for studying magnetic material, in which an external magnetic field is rotated, and the magneto-optical (MO)response of the sample is recorded as a function of the field angle[1]. MO effects quadratic in M ("Q-MOKE"), display a weak dependence on the incidence angle. In ROT-MOKE experiment, the QMOKE has been utilized to establish magnetic anisotropy of iron films [2]. Here, we propose a different approach, based on the analysis of full polarization dependence of the MO signals.
We used a thin film FeRh, material that is ferromagnetic above 380 K with near-normal incidence and varied the angle of incident polarization orientation. External magnetic field of 207 mT was rotated in the sample plane. The result showed that both the shape and the amplitude of the curves changes with polarization. By recalculating the polarization dependence, we were able to extract magnetic anisotropy of the material with high precision. This method thus opens a path to all-optical, highly sensitive magnetometry of a whole range of magnetic materials.
[1]Hamidi, S. M. and Tehranchi, M. M., J. Supercond. Nov. Magn. 26, 1585 (2013)
[2]Liang, J. H.. et al., Optics express 23, 11357 (2015)

### Projected climate change using CMIP6 models over Central Europe

***Dhib S.**, Halenka T, Holtanova E., and Belda M.*

**Abstract.** The aim of this study is to estimate changes in rainfall and temperature indices in Central Europe. Based on 13 climate models and four SSP scenarios, 5 relevant climate indices were calculated with various thresholds. The evaluation within Eobs data shows a good correlation for very heavy precipitation. A wide variation of indices estimation is observed among the 13 models. Based on their ensemble results, these models predict a greater prevalence of very heavy precipitation, consecutive dry days, summer days, and tropical nights indices.

### Planetary Boundary Layer and Long-range Transport Effect on Black Carbon Concentration Under Different Meteorological Conditions

***Julaha K.**, Zikova N. , Mbengue S., and Zdimal V.*

**Abstract.** Absorbing aerosols, consisting mainly of black carbon, interact strongly with the planetary boundary layer (PBL). This study used eBC concentration measured at 4m and 230m on a 250 m-meteorological tower. The PBL height was taken from the ERA5 dataset. The mean eBC concentration was found the highest in winter, lower in spring and autumn, and the lowest during the summer. In contrast, the average PBL height was the lowest in autumn, followed by summer and winter, and was measured the highest during the spring due to the higher number of rainy days in summer, resulting in lower PBL height. The eBC concentration at 4m showed peaks during mornings and evenings, likely due to local sources and the PBL diurnal evolution but an opposite diurnal pattern was observed at 230 m. Elevated eBC concentrations during noon and late-night have also been observed, driven by the transport of aerosols from distant sources. The development of PBL was suppressed by fog and haze, further weakening the diffusion of aerosols, leading to higher eBC concentration at the ground. High RH (≈ 100 %) with high temperature (28.4 °C) yields the highest PBL height and higher eBC concentration at 4m compared to 230 m.

## Extreme PM and Ozone Pollution over Central Europe: Interactions of the Urban Canopy Meteorological Forcing and Radiative Effects of Urban Emissions

***Prieto Perez A.P.**, Huszar P., and Karlicky J.*

**Abstract.** Extreme air pollution in European cities persists today, being a large health burden on their inhabitants. Understanding the processes that control or modulate such events over urban areas is therefore crucial. In this study, based on two air pollution events in August 2015 and January 2017, we examine the mutual role of urban emissions (and secondary pollutants formed from them) and the urban canopy meteorological forcing (UCMF) over central Europe. We performed a series of WRF-Chem simulations with/without urban land-surface and with/without urban emissions, while eight large central European cities were considered. Impact on meteorological conditions and chemical species is examined. As for the impact on meteorological conditions, we showed that the direct effect of UCMF is much larger than the secondary effects of the radiative impacts of urban emissions. We also showed that these radiative impacts depend whether UCMF is included or not. The impact on chemical concentrations is driven especially by UCMF causing decrease of PM and increase of ozone while the indirect effects of urban emissions induced meteorological changes are substantially smaller.

**Sensitivity Tests of the Initial and Boundary Conditions of the PALM Model**

***Radović J.**, Belda M., Resler J., Krc P., Bures M., Eben K., and Geletic J.*

**Abstract.** The PALM model is an atmospheric modeling system that is capable of simulating physical processes within the urban boundary layer and it is driven by the initial and boundary conditions taken from the mesoscale atmospheric models. The motivation behind this experiment was to obtain the best possible initial and boundary conditions for driving the mentioned model. In the course of this study three PALM model simulations were performed using three different sets of initial and boundary conditions obtained from the mesoscale numerical model called WRF. The simulations were performed on an 8 x 8 km domain in 10 m resolution which is capturing a real city area in the southeast part of Prague. A comparison of the WRF model outputs and PALM model outputs against the observations represented by atmospheric soundings was performed as well. The conducted simulations and comparisons showed that the PALM model outputs agree well with the imposed initial and boundary conditions for the given time period confirming the need for high-quality driving data. Further studies with other available mesoscale models and for different weather situations need to be performed in this regard.

# F-9 PARTICLE AND NUCLEAR PHYSICS

## Electroproduction of Hypernuclei

***Denisova D.***

**Abstract.** Electroproduction of hypernuclei is an object of current interest. Precise and reliable predictions of the cross sections in hypernucelus electroproduction are important both in planning experiments and data analysis. We will discuss some uncertainties in description of the reaction mechanism based on impulse approximation, particularly, we will show effects of proton motion in the target nucleus (Fermi motion effects) and other kinematical effects usually used in current calculations. Including the Fermi motion allows us to go beyond the "frozen proton approximation" and in this way improve our previous DWIA calculations assuming an optimum value of the target-proton momentum. To this end we have also developed a general CGNL-like formalism for the elementary amplitude which allows to evaluate the two-component form of the amplitude in a general reference frame. The effects of various approaches will be demonstrated on the angular and energy dependent cross sections in hypernucleus electroproduction.

## Determining the Mass Limit of the Gauge Leptoquark

***Gedeonova H.* and Hudec M.**

**Abstract.** The gauge leptoquarks predicted by the model of Pati-Salam type gained a lot of attention in recent years as they might serve as a possible explanation of the B-mesons anomalies. The current measurements put stringent lower limit on the leptoquark mass which remains an unknown value. By analytic considerations, we have determined which mesonic decays are the most relevant for future searches for the leptoquark existence and what is the lowest possible leptoquark mass compatible with present experimental data.

## Search for Lepton Flavour Universality Violation in Tau Lepton Decays at Belle II

***Gruberova Z.***

**Abstract.** The Belle II experiment is an upgrade of the Belle detector, operating since 2018 at the SuperKEKB energy-asymmetric $e^+e^-$ collider. Belle II has a broad physics program including tau lepton physics, from high-precision Standard Model measurements to New Physics searches such as Lepton Flavour Universality (LFU) violation. This talk will introduce the Belle II experiment, briefly review the status of LFU measurements and present the Belle II strategy for measuring R mu ratio in tau lepton decays.

## Measurement of the Dijet Cross-section in Proton–Proton Collisions at the ATLAS Experiment at CERN

***Polacek S.***

**Abstract.** Jet production cross-section measurements using the ATLAS experiment and the Large Hadron Collider in CERN give us information about, for example, the strong coupling constant and the internal structure of a proton. The goal of the measurement is to present the double-differential dijet cross-section as a function of the dijet invariant mass and rapidity separation of the two jets using the ATLAS 2015–2018 physics data from proton–proton collisions at a center-of-mass energy of 13 TeV.

## F-11 MATHEMATICAL AND COMPUTER MODELLING

**Numerical Simulations of Hydrodynamic Journal Bearings with Nanolubricants**

***Verma R.* and Sharma S.**

**Abstract.** Nanolubricants are oils containing nanoparticles as additives to enhance the performance of journal bearings. Hydrodynamic journal bearings can be described by the Reynolds Equation accompanied by a formula for the fluid film thickness. The equations were discretized and solved in Matlab by an iterative method. The performance characteristics and fluid pressure distributions were evaluated for two different nanoadditives, CuO and $Al_2O_3$, with varying temperature and nanoparticle concentration.

### Search of Science Textbooks Analysis

***Fürstova T.***

**Abstract.** This contribution is part of my thesis which follows up on the thesis Starting points for a new physics curriculum (by Petr Kolar). The aim is to pilot a new physics textbook for upper secondary schools, which is being created at the Department of Physics Education (MFF UK). Currently the search of international literature is in progress. I describe the process of the search focused on science textbook analysis and I mention methodology that was used in selected studies in this area.

### Telescopes in the Physics Education in the Czech Republic

***Hlozek F.***

**Abstract.** This contribution presents the result from the questionnaire about using telescopes in education. The research was done among Czech physics teachers in spring 2021. Our intention was to answer following research questions: What knowledge do physics teachers have about telescopes and is this knowledge related to years of working experience as a teacher and to experience with observing the sky with telescopes? Do teachers have enough time and supplies for detailed explanation of the principles and use of the telescopes to their students? Is the time devoted to teaching about the telescopes conditioned by the type of the school? Do teachers only explain to students how the telescopes work or do they actually give to students the real experience? The processed results unfortunately confirm our hypothesis that most teachers lack more practical experience working with the telescopes and deeper knowledge about them as most of the teachers admit that they know only what is written in the textbooks. Other more or less surprising results will be given in this contribution.

## Future Use of Eye-tracking in Physics Education

***Krejci A.***

**Abstract.** Eye-tracking is being used to conduct research in many different fields, including education science. However, the choice and interpretation of eye-tracking indicators can significantly vary based on the specific subject of the study — data obtained from reading a book will differ from data from solving a physics problem or classifying fish movements. In the first stage of this study, we conducted a literary research and created a table of indicators that could be useful not only in educational research but also directly in physics education. This would provide teachers with additional, on-line information about their students studying or completing tests. The table contains suggested interpretations of said indicators. The next goal of this research will be testing selected indicators on relevant material, e.g., physics textbook excerpts or physics problems, followed by creating a handbook for teachers on how to use eye-tracking in their praxis.

## Research Design of an Ongoing Research on Students' Perception of Physics Demonstrations

***Nikitin A., Chval M., Kacovsky P., Mandikova D., Pavelkova I., and Snetinova M.***

**Abstract.** The purpose of this paper is to present a developed research design of a video-study focusing on parameters that influence how upper-secondary school (SS) students perceive physics demonstrations. The emphasis in this study lies on the assessment of the demonstrations by several different groups of people involved in SS physics education (teachers, students, pre-service teachers, pre-service teacher trainers). The aim of this study is to determine whether these groups perceive the demonstrations differently from the students who usually attend them.

### The Current State of the Maturita Examination in Physics in the Czech Republic

***Pschotnerova P.***

**Abstract.** Based on a literature search from the 1st year of my studies, we conducted a questionnaire survey, the results of which will be included in the poster. The questionnaires were filled out by Czech physics teachers and students who chose to take the Maturita exam in physics. We were interested in time allotment for physics at gymnasiums and technical lyceums, the proportion of school leaving students taking the Maturita exam in physics, the form of the exam, and also the methods and sources of information used to prepare for the examination.

### First Year Conclusions of Experimental Implementation of Using Mentors Method in Physics at Grammar School

***Šmahel J.***

**Abstract.** This article presents the conclusions of the first year of experimental implementation of mentoring method at the Kadaň Grammar School. This year was the first of systematically testing the work of mentors in three classes of a higher grammar school. An experimental attempt to introduce the method brought several unexpected experiences, which were shown thanks to the practical and systematic application of the method in a real teaching process. The article briefly introduces this method, the experience gained after the first year of its trial application and an outline of the next steps in the research of this method.

## F-13 PHYSICS OF NANOSTRUCTURES

### *In-situ* Loading on Defect Containing Material Observed under High-resolution Tomograph

***Ahmed U., Simek D., and Horak L.***

**Abstract.** In this research, a dog-bone shaped sample of NiTi is being analysed under X-ray Computed Tomography. The *in-situ* tensile testing was performed at –20C with different load i.e., 10 N, 150 N, 220 N and 300 N using Deben chamber of Xradia Versa 610, Zeiss. The sample had 4.2 mm gauge length, 1 mm width and 1 mm height. The reconstructed images and large number of pores/inclusions were being analyzed using DragonFly software. Images obtained under different loading were compared, dimensional changes in the pores/inclusions were determined as well as changes in the distances amongst different pores were calculated. The sample showed 1% deformation at 150 N, 3.80% at 220 N and 5.4% deformation at 300 N.

### Spontaneous Anomalous Hall Effect Arising from Antiparallel Magnetic Order in a Semiconductor

***Gonzalez Betancourt R.D., Zubac J., Gonzalez Hernandez R.J., Geishendorf K., Soban Z., Springholz G., Olejnik K., Smejkal L., Jungwirth T., B. Goennenwein S.T., Thomas A., Reichlova H., Zelezny J., and Kriegner D.***

**Abstract.** It is known that collinear antiferromagnets cannot host a spin split band structure and therefore not show any anomalous Hall effect. Following the recent theory development [1], we experimentally show that this paradigm needs to be revised. We theoretically identify and experimentally confirm the symmetry components of the longitudinal and transversal anisotropic magnetoresistance in thin films of the compensated collinear antiferromagnetic semiconductor MnTe. In a Hall bar fabricated in c plane oriented thin films, we experimentally find a hysteretic signal odd in magnetic field in the transversal magnetoresistance, i.e., spontaneous anomalous Hall effect. This effect can be rationalized considering nonmagnetic atoms at non-centrosymmetric lattice sites which break additional symmetries and cause a spin splitting in certain parts of the Brillouin zone.

[1] L. Smejkal et al., Sci. Adv. 6, aaz8809(2020)

### X-Ray Diffraction on Modulated SIO/STO Multilayer

***Machovec P.* and Horak L.**

**Abstract.** During x-ray characterization of SIO/STO superlattice, we observed a splitting and shift of satellite peaks in 2theta/theta scan. We investigated this effect by reciprocal space mapping. These measurements indicate a modulation of the composition in out of plane direction with period, that is non-integer multiple of mean out of plane lattice parameter. We successfully simulated X-ray scattering on such a structure and we introduce a method to calculate this modulation.

### Probing 2D Magnets with Raman Spectroscopy

***Zacek M.***

**Abstract.** The two-dimensional (2D) magnetic materials have attracted much interest recently. For studies of these materials, Raman spectroscopy is an excellent tool for probing the magnetic ordering as this method can deliver convincing results even in atomically thin materials. Some results obtained on 2D magnets using a unique confocal Raman microscope operating at low temperature and high magnetic field environment with the full polarization analysis in backscattering geometry will be presented.