SECOND MULTIDISCIPLINARY CONFERENCE

OF THE ITALIAN RESEARCHERS IN THE CZECH REPUBLIC

7-9 June 2023

ORAL PRESENTATIONS - ABSTRACTS

1)

Chasing quantum gravity with a pencil

Alfredo Iorio

Faculty of Mathematics and Physycs, Charles University

I shall review why in Dirac materials, like graphene, special relativistic-like matter and space may emerge. I shall then show how aspects of gravity theories may be reproduced as well. These include effects typical of quantum fields in the presence of black-holes, leading to a Unruh-Hawking kind of phenomenon, as proposed by our research group at the MatFyz of Charles University, more than a decade ago.
I shall then mention as many fresh results of our group, as time permits. From the time-loop to spot torsion, to the generalized uncertainty principles of quantum gravity stemming from and underlying (lattice) length; from a model of grain-boundaries and their relation to (A)dS and Poincaré spacetime algebras, to Unconventional Supersymmetry and the role of the two Dirac points.
Acknowledgements: I am deeply indebted to my coathors Pablo Pais, Paolo Castorina, Luca Smaldone, Giovanni Acquaviva, Ruggero Gabbrielli, Boris Ivetic, Salvatore Mignemi, Marcelo Ciappina, Adamantia Zampeli, Gaetano Lambiase and to Raffaele Agostino, Francisco Correa, Arundhati Dasgupta, Gaston Giribet, Artem Grebenko, Paco Guinea, Vit Jakubsky, Siddhartha Sen, Guillermo Silva, Maria Vozmediano and Jorge Zanelli, for the many stimulating and informative discussions on the experimental and theoretical physics of this “graphene analog enterprize”.

Reference: [Most recent review] G Acquaviva, A Iorio, P Pais, L Smaldone, Hunting Quantum Gravity with Analogs: The Case of Graphene, Universe 8 (2022) 455

2)

ELI Beamlines: the high-peak, high-average power laser facility of the Extreme Light Infrastructure

Daniele Margarone

ELI Beamlines Facility, The Extreme Light Infrastructure ERIC, Dolni Brezany, Czech Republic

The ELI Beamlines Facility is a pillar of the ELI (Extreme Light Infrastructure) ERIC pan-European Research Infrastructure hosting the world's most intense laser sources. ELI Beamlines developed and operates four cutting edge high-peak, high-average power femtosecond laser systems and offers a unique combination of primary (lasers up to 10 PW peak power) and secondary (high-energy particles and X-rays) sources to the international user community. Currently, several beamlines are operational and being upgraded to reach their full performances, while other beamlines are in their commissioning phase. Laser-driven particle accelerators have gained interest in the recent years thanks to their versatility and innovative features. This interest has pushed forward the development of beamlines where users can exploit the unique parameters (e.g. ultrashort bunch duration and ultrahigh dose rate) of laser-driven particle accelerators (ion and electron beams) and radiation (XUV to gamma-ray sources) for a wide range of applications. The current performance of particle and radiation sources available at the ELI Beamlines user facility will be presented and discussed along with their potential use for multidisciplinary applications. The high repetition rate capability of the available primary and secondary sources will be highlighted in combination with a range of advanced target delivery solutions and diagnostics in operation in extreme laser-plasma conditions (>1021 W/cm2 at >1 Hz and >5x1018 W/cm2 at 1 kHz)

3)

Commissioning experiments at the ELIMAIA user beamline

Lorenzo Giuffrida[1], F. Schillaci[1], F. Grepl[1, 2], M. Tryus[1], S. Stancek[1, 3], A. Velyhan[1], V. Istokskaia[1,2], G.A.P. Cirrone[4, 1], J. Cupal[1, 2], L. Koubikova[1], D. Peceli[1], J. A. Jarboe[1], T. Chagovets[1], V. Kantarelou[1], N. Gamaiunova[1], A. Hadjikyriacou[1, 2], J. Psikal[1, 3], T. Levato[1], M. Tosca[1, 5], M. Borghesi[6], B. Rus[1], and D. Margarone[1]

[1] ELI–Beamlines Center, Institute of Physics, Czech Academy of Sciences, Dolni Brezany, Czech Republic; [2] Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Prague, Czech Republic; [3] Joint Laboratory of Optics of Palacky University, Institute of Physics of Academy of Sciences of the Czech Republic, Faculty of Science, Palacky University, Olomouc, Czech Republic; [4] Laboratori Nazionali del Sud, INFN, Catania, Italy; [5] Charles University, Faculty of Mathematics and Physics, Department of Macromolecular Physics, Prague, Czech Republic; [6] Centre for Plasma Physics, School of Mathematics and Physics, Queen's University Belfast, Belfast BT7 1NN, United Kingdom

The ELI Multidisciplinary Applications of laser-Ion Acceleration (ELIMAIA) beamline is the laser-driven ion target area available at ELI Beamlines facility (Czech Rep.), having as final goal to provide a fully characterized and tuneable ion source generated by the HAPLS PW-class laser (>10J in <30 fs), working at relativistic intensities (>10^{21} W/cm2) and in repetition-rate (up to 10 Hz), for multidisciplinary applications.

We will report here the commissioning of the beamline, necessary to evaluate the performances of the system. Using targets of different composition and thickness, we were able to optimize the performance of the laser-plasma Ion Accelerator, obtaining in the optimal case proton energy cut-offs well beyond 30 MeV fluxes above 10^{11}/sr/shot. Moreover, we have demonstrated an excellent reliability and shot-to-shot stability (1-2% in energy) of the Ion Accelerator up to a repetition rate of 0.5 Hz for several hundreds of consecutive shots, along with on-shot target positioning and data acquisition and analysis systems.
These results demonstrate the robustness of the developed technology available for users at the ELIMAIA beamline, thus paving the way towards its future use for fundamental and applied research, including biomedical ones.
Adknowledgements: This research was funded by the Ministry of Education, Youth and Sports of the Czech Republic by the project "Advanced Research Using High Intensity Laser Produced Photons and Particles" (CZ.02.1.01/0.0/0.0/16_019/0000789) and the IMPULSE project by the European Union Framework Program for Research and Innovation Horizon 2020 under grant agreement no. 871161.

4)

A multi-MeV alpha particle source via proton-boron fusion driven by a 10-GW tabletop laser

V. Istokskaia, M. Tosca, **L. Giuffrida**, J. Psikal, F. Grepl, V. Kantarelou, S. Stancek, A. Hadjikyriacou, A. McIlvenny, Y. Levy, J. Huynh, M. Cimrman, P. Pleskunov, D. Nikitin, A. Choukourov, F. Belloni, A. Picciotto, S. Kar, M. Borghesi, A. Lucianetti, T. Mocek, **D. Margarone**

ELI Beamlines Facility, The Extreme Light Infrastructure ERIC, Dolni Brezany, Czech Republic;

Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Prague Czech Republic; Charles University, Faculty of Mathematics and Physics, Department of Macromolecular Physics, Prague, Czech Republic; Centre for Light-Matter Interactions, School of Mathematics and Physics, Queen's University Belfast, Belfast, United Kingdom; HiLASE Centre, Institute of Physics (FZU), Czech Academy of Sciences, Dolni Brezany, Czech Republic; School of Electrical Engineering and Telecommunications, Faculty of Engineering, UNSW Sydney, Sydney, Australia; Micro-Nano Facility - Sensors and Devices Center, Fondazione Bruno Kessler (FBK), Trento, Italy.

Nuclear fusion between protons and boron-11 nuclei has undergone a revival of interest thanks to the rapid progress in pulsed laser technology. Potential applications of such reaction range from controlled nuclear fusion to radiobiology and cancer therapy. A laser-driven fusion approach consists in the interaction of high-power, high-intensity pulses with H- and B-rich targets. We report on an experiment exploiting proton-boron fusion in CN-BN targets to obtain high-energy alpha particle beams (up to 5 MeV) using a very compact approach and a tabletop laser system with a peak power of ~10 GW, which can operate at high-repetition rate (up to 1 kHz). The secondary resonance in the cross section of proton-boron fusion (~150 keV in the center-of-mass frame) is exploited using a laser-based approach. The generated alpha particles are characterized in terms of energy, flux, and angular distribution using solid-state nuclear-track detectors, demonstrating a flux of ~105 particles per second at 10 Hz, and ~106 per second at 1 kHz. Hydrodynamic and particle-in-cell numerical simulations support our experimental findings. Potential impact of our approach on future spread of ultra-compact, multi-MeV alpha particle sources driven by moderate intensity (1016-1017 W/cm2) laser pulses is anticipated.
Adknowledgements: This research was funded by the Ministry of Education, Youth, and Sports of the Czech Republic through the project "Advanced Research Using High-Intensity Laser-Produced Photons and Particles" (CZ.02.1.010.00.016_0190000789), the European Union's Horizon 2020 research and

innovation program (Grant agreement no. 871124, LASERLAB-EUROPE), the project “Target Engineering for Proton-Boron Nuclear Fusion Studies” sponsored by the UK Royal Society, and the EUROfusion Consortium, which was funded by the European Union via the Euratom Research and Training Program (Grant agreement no. 101052200—EUROfusion).

5)

The FLUKA.CERN collaboration

Roberto Versaci, A. Cimmino, D. Horvath, B. Lefebvre

ELI Beamlines Facility, The Extreme Light Infrastructure ERIC, Dolny Brezany TESTO:

In physics, Monte Carlo simulations are an effective way to calculate macroscopic quantities starting from the description of elemental phenomena. They have been at the hearth of scientific research in nuclear and particle physics for the past 80 years.
ELI Beamlines is a founding member of the FLUKA.CERN collaboration, which develops the FLUKA Monte Carlo code, a worldwide-recognized standard. The FLUKA Monte Carlo code is able to simulate the transport of several tens of particles: from the light neutrinos to the heavy ions, including the nasty low-energy neutrons. It is able to simulate a large amount of fundamental processes: electromagnetic interactions of photons, electrons, and muon; hadron-hadron, hadron-nucleus, and nucleus-nucleus interactions, low-energy neutrons interactions, and particles decays. The code is able to simulate electric and magnetic fields.
FLUKA has a wide range of applications including but not limited to particle physics, accelerator design, detector development, radiation protection, dosimetry, radiation damage, cosmic rays, and medical applications.
This contribution will provide an introduction to the FLUKA Monte Carlo code and its many applications. Then it will describe the activities of the ELI Beamlines group particularly focusing on those involving collaborations with external institutes.

6)

Radiation protection at ELI Beamlines

Anna Cimmino, D. Horváth, B. Lefebvre, V. Olšovcová, M. Šestak, R. Truneček, R. Versaci

ELI Beamlines Facility, The Extreme Light Infrastructure ERIC, Dolny Brezany

In 2021, the European Commission established the Extreme Light Infrastructure (ELI) project as an European Research Infrastructure Consortium (ERIC), thus creating a one-of-a-kind legal entity, ELI ERIC. ELI ERIC is the largest international civilian laser-based user facility network. The establishment of ELI ERIC enable researchers and industries to access the world’s largest collection of high-power and ultra-fast lasers. Located in the Czech Republic, the “ELI Beamlines” pillar of the consortium, aims at investigating high-field high-density physics, developing high-brightness sources of X-rays, as well as secondary proton, electron, and ion beams, for interdisciplinary applications in physics, medicine, biology, and material sciences. Lasers as powerful as those used in the facility will generate a significant amount of ionizing radiation that can dangerous to both humans (personnel, visitors, and general public) and technology. The task of the ELI Beamlines radiation protection group is to guarantee that the whole laboratory and its surroundings are safe from the produced ionizing radiation. In this

contribution, the radiation protection challenges will be discussed and the mitigation strategies implemented will be presented.

7)

The long march toward zero friction

Mengzhou Liao[1,2], **Paolo Nicolini**[2,3]

[1] Beijing National Laboratory for Condensed Matter Physics and Institute of Physics, Chinese Academy of Sciences, Beijing, China
[2] Department of Control Engineering, Faculty of Electrical Engineering, Czech Technical University in Prague, Prague, Czech Republic
[3] Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic

Friction causes massive energy dissipation and mechanical abrasion between machine component parts in the world every year (costing approximately 3.3· 〖10〗 ^13 kWh[1]). Understanding the mechanism of the frictional processes and searching for an optimum material combination, ideally providing a near frictionless state, are thus essential. Recent works show that near-zero interface friction can be realized in twisted 2D materials or 2D heterostructures due to their ultra-flat interface potential energy surface. However, the origin of friction is complex. Suppressing one primary source will make friction from other mechanisms to surface. Thus, reaching a pure zero friction state is going to be a long march.
In this talk, I will report the friction phenomenon in superlubric MoS2/graphite and MoS2/h-BN van der Waals heterostructure interfaces. In such systems, instead of reaching a frictionless state with a suppressed interface friction, mechanisms like the edge pinning effect[2] and the shape of the structural potential energy[3] start to dominate the friction processes and provide friction during the sliding and twisting. Those phenomena explain why it is hard to realize low friction on the macro scale. I will also further discuss the main challenges and provide possible ways toward a pure zero friction state[4].
References:
[1] K. Holmberg, A. Erdemir, “Influence of tribology on global energy consumption, costs and emissions“. Friction, 5, 263 (2017).
[2] M. Liao, P. Nicolini, L. Du, J. Yuan et al., “Ultra-low friction and edge-pinning effect in large-lattice-mismatch van der Waals heterostructures“. Nat. Mater., 21, 47 (2022).
[3] M. Liao, A. Silva, L. Du, P. Nicolini et al., “Twisting Dynamics of Large Lattice-Mismatch van der Waals Heterostructures“. ACS Appl. Mater. Interfaces, 15, 19616 (2023).
[4] M. Liao, P. Nicolini, T. Polcar, “Separating anisotropic and isotropic friction between atomic force microscope tips and atomically flat surfaces”. Under review in Phys. Rev. B (2023).

8)

Turbulent flows of superfluid helium-4: an introduction

Marco La Mantia

Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic

The investigation of turbulent flows of superfluid helium-4 is an active and challenging research field,

which is not only interesting in its own right but that has also broader implications, related, for example, to neutron stars or to turbulence in classical viscous fluids, such as water and aird Indeed, superfluid helium-4 is characterized by unique properties, edgd in certain conditions, it apparently flows without friction, as if it were a perfect (inviscid) fluidd In order to explain some of its remarkable features, it is often described as a quantum liquid, ided its turbulent flows are defined by the presence of quantized vortices, which are line singularities within the superfluid and can be viewed as the carriers of the flow vorticityd Special emphasis is given to the visualization of turbulent flows of superfluid helium-4, which in recent years has significantly contributed to our understanding of the underlying physics (the first laboratory in Europe to be exclusively devoted to such measurements has been established at Charles University: its design and implementation was the focus of my work, when I was hired in 2009, and I am now responsible of its scientific activities)d Selected experimental findings are reviewed, especially to highlight close similarities, as well as striking differences, with classical turbulent flows of viscous fluidsd For example, it has been shown that quantum features are apparent at flow scales smaller than the mean distance between quantized vortices, while, at larger scales, a classical-like picture is observed in some cases, especially when thermal effects can be neglected.

9)

Uncovering the Hidden Potentials of Materials: Exploring the Electrical Properties of the objects That Surround Us

Francesco Piana

Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic v.v.i., Prague , Czech Republic

In the last 15 years, I have been on a journey exploring the properties of various materials commonly used in daily life, but often overlooked by the public. This journey has taken me from the lab bench to the real world, where my colleagues and I have applied our knowledge to try developing innovative solutions.

I started by working on conductive graphite embedded in polymers for applications such as electromagnetic shielding, antistatic coatings, and barriers against gas or fire. However, low conductive, insulating materials also play a critical role in modern technology. For example, high permittivity barium titanate embedded in plastics is essential for flexible electronics, where the ability of preventing the passage of electric current and transmit the electromagnetic field is crucial in devices like transistors.

More recently, I have worked on cement/carbon nanotube composites for self-sensing applications, where the materials themselves can detect chemical and structural changes and communicate them to supervisors. In this case, the electrical performance helps maintain buildings and urban elements, increasing their lifetime while reducing costs and pollution.

I have also explored the potential of collagen/chitin nanocrystals as scaffolds for tissue regeneration, where their piezoelectric properties determine the quality and speed of the healing process. Mechanical stress applied to the material generates a small electric current that stimulates cell growth, reproduction, and tissue repair.

In this presentation, I will share my journey and showcase some of the applications developed using these often-overlooked materials in solving real-world problems.

Adknowledgements:

I want to thank the department leader Dr. Jiří Pfleger and all the colleagues of the department of Polymers for Electronics and Photonics for their scientific contributions. For the financial support, my thanks go to MYAS, GAČR and TAČR who funded our research projects all these years.

10)

Hydrogen sulfide and sperm biology: from poison to remedy

Eliana Pintus and José Luis Ros-Santaella

Department of Veterinary Sciences, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences, Prague, Czech Republic

Hydrogen sulfide (H2S) is a colorless and water-soluble gas that typically smells like rotten eggs and is naturally found in volcanic springs and decomposed organic matters. After being regarded as a mere poison for decades, H2S is now recognized as an endogenous gaseous molecule having both a physiological and pathological role in cells and tissues. Because of its antioxidant properties, H2S has shown the ability to palliate the damages induced by oxidative stress, which is characterized by an imbalance between reactive oxygen species (ROS) and antioxidant levels. Sperm cells are particularly susceptible to the injuries provoked by oxidative stress because of their unique plasma membrane composition and their limited antioxidant defense. Although small levels of ROS are physiologically required for sperm function and fertilization process, their overproduction, which can arise because of pathological conditions or semen manipulation for assisted reproductive techniques, is detrimental for the male fertility.

In this presentation, I will overview the most recent advances about the role of H2S on the male reproductive system, the effects of different H2S donors on sperm quality and their potential application for treating sperm fertility disorders, with a special focus on those associated with oxidative stress. Overall, we found that H2S protects sperm cells against the deleterious consequences of oxidative stress, although the effects are both donor and dose dependent. Moreover, some H2S donors have shown a clear positive effect on sperm mitochondrial activity, which can be particularly useful to explore the role of H2S in sperm mitochondria-dependent events such as apoptosis or fertilization.

Acknowledgements: We would like to thank our former and current Ph.D. students and our colleagues Prof. Matson (Virginia Polytechnic Institute and State University, USA), Prof. García-Vázquez (University of Murcia, Spain), and Dr. Novy (Czech University of Life Sciences Prague) for their collaboration.

11)

Implication of sperm size and shape in animal andrology

José Luis Ros-Santaella and Eliana Pintus

Department of Veterinary Sciences, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague

Spermatozoa are the most diverse cells in the animal kingdom. They are ejected from the body into an unknown environment where they live as free-living organisms. Accordingly, spermatozoa of each species are adapted to their specific fertilization environment. The environments where sperm cells carry out fertilization are very diverse, so they have developed very specific adaptations to them, with a high variability in their structural components that result in a high morphological diversity among animal species. Sperm size also drastically varies across species ranging from 6 to ~60,000 µm, being the longest sperm found in the tiny fruit fly Drosophila bifurca. Intraspecific studies have investigated whether sperm size determines sperm lifespan, velocity, and fertilization capability, but, in general,

contradictory results or no correlations were found. Similarly, studies concerning the implication of sperm size in their ability to withstand the cryopreservation process are scarce and focused on the sperm head only.
The present communication aims to describe the relationships between intra-male variation in sperm size and sperm quality, the implication of sperm cell dimension in sperm freezability, and the effects of nutrition on sperm shape. Finally, we aimed to assess the main sperm traits in unique species with interest in conservation breeding programs. Overall, we found that the sperm size homogeneity is related to increased testis size, spermatogenic activity, and sperm quality. Our results also show a strong relationship between the volume of the sperm flagellum with sperm freezability, that is, sperm with a higher flagellum volume freeze worse. Moreover, we reported that a high-energy diet administered to pubertal fallow deer promotes an increase in the sperm midpiece where the mitochondria are located. The assessment of sperm morphometry can reveal new insights into the biological processes and the multiple adaptations to the fertilization environment of these cells.
Acknowledgements: We would like to thank our former Ph.D. students and our colleagues from Czech University of Life Sciences Prague (Czech Republic), University of Murcia (Spain), and University of Castilla-La Mancha (Spain) for their collaboration.

12)

Cat's claw (Uncaria tomentosa): a natural source of antioxidants for sperm preservation

Maria Scaringi, José Luis Ros-Santaella and Eliana Pintus

Department of Veterinary Sciences, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Praha 6-Suchdol, Czech Republic

Uncaria tomentosa (UT), commonly known as cat's claw is a vite that belongs to the Rubiaceae family and is native to different areas of South and Central America. Various parts of the plant, in particular bark and leaves, are used in traditional medicine due to their therapeutic activities. Among them, the antioxidant activity is attributed to the presence of polyphenols. Oxidative stress, which is provoked by high levels of reactive oxygen species and reduced antioxidant defences, is one of the main causes of reduced sperm survival during semen storage for artificial insemination purposes. In this study, boar semen was supplemented with four concentrations (i.e., 48, 12, 3, and 0.75 µg/mL) of UT bark ethanolic extract. The total antioxidant capacity of the stock extract (200 mg/mL) was 3.77±0.01 mM of Trolox equivalents. The effects of the extracts on the sperm samples were evaluated during storage at 17°C (48h and 96h) and under oxidative stress, which was induced by two different ROS-generating systems (i.e., H_2O_2 and Fe^{2+}/Ascorbate). The motility, kinetics and viability of the sperm samples were evaluated. Sperm motility and kinetics were assessed by a computer-assisted sperm analyzer. The viability was evaluated under epifluorescence microscopy, after incubating the samples with carboxyfluorescein diacetate and propidium iodide.
Our results indicate that during semen storage and under oxidative stress cat's claw showed significant positive effect on sperm viability; conversely, there were no effects on motility and kinetics. In particular, at 48h of storage, UT 48 better preserved the sperm viability than the control group. Instead, under oxidative stress, there was a significant difference between the oxidized control and UT 0.75, which did not differ from the non-oxidized control group. Therefore, the UT extract could be used as a natural source of antioxidants for the preservation of boar semen viability.
Acknowledgements: project „Alternativní aditiva ředidel kančího ejakulátu jako náhrada antibiotik" (NAZV QK21010327)

13)

Thermo-hydro-mechanics of landslides under climate change

Gianvito Scaringi

Institute of Hydrogeology, Engineering Geology and Applied Geophysics, Faculty of Science, Charles University

Landslide initiation and dynamics are investigated with methods that are specific to the scale of investigation. Hydro-mechanical models are the go-to for individual landslides as they rely on the well-studied coupling between hydrological input – via atmosphere-soil interaction – and mechanical response. At larger scales, these models gradually give way to simpler physics-based approaches and finally to geostatistical models. The role of temperature in controlling evapotranspiration and thus the hydrological balance is well recognized and featured in models; conversely, direct thermo-mechanical couplings are systematically neglected unless changes in water phase are involved. This contrasts with experimental evidence of a fully-coupled thermo-hydro-mechanical behaviour of most geomaterials. Temperature-dependent processes are potentially relevant to slope stability, especially in clayey slopes in temperate and warm regions.
Here, the thought-provoking hypothesis is that temperature fluctuations and trends induced by climate change may cause, in short to long terms, a disturbance to mechanical equilibria in slopes (by altering permeability, water retention capacity, compressibility, shear strength). Together with other known effects, such as altered precipitation patterns and changes in land use, this disturbance could affect landslide activity and the distribution and frequency of slope movements. To verify this hypothesis across the scales, systematic field monitoring of temperature-related variables is necessary, together with geostatistical analyses entailing thermal remote sensing products. At the same time, fully-coupled approaches need to be upscaled to permit physically-based catchment- or regional-scale studies accounting for appropriate temperature-related variables and the inherent heterogeneity in materials and boundary conditions.

14)

Metal soaps in oil paintings over the centuries

Silvia Garrappa[1], Silvie Švarcová[1], Janka Hradilová[2], Petr Bezdička[1], David Hradil[1,2]

[1] Institute of Inorganic Chemistry of the Czech Academy of Sciences, ALMA Laboratory, 250 68 Husinec-Řež, Czech Republic
[2] Academy of Fine Arts in Prague, ALMA Laboratory, U Akademie 4, 170 22 Prague 7, Czech Republic

Metal carboxylates formation is a well-known issue in oil paintings, and it is one of the most recurrent topic in conservation science research of the last 20 years (1). During the lifetime of an oil painting, free carboxylic acids (R—COOH) derived from drying oils can react with the metal cations from some pigments (e.g., lead-based and zinc-based ones) leading to the formation of metal carboxylates, which are characterized by the general formula M+(RCOO-) (1). These products of pigment-binder interaction can reveal themselves in various ways, namely, aggregates, efflorescent crusts, crystalline exudates, blisters, and cracks (2). These phenomena have been detected in numerous paintings and are now acknowledged as a part of the dynamics of the aging of oil paints (2). Despite numerous researches focused on this degradation process, there are still many unresolved questions concerning the formation and behaviour of metal carboxylates. In this presentation, the symptoms manifested by the presence of crystalline metal carboxylates (metal soaps) together with the detailed characterization of saponified paint layers will be showed. Furthermore, a comparison of different analytical methods

involving X-ray fluorescence (XRF), X-ray powder diffraction (XRPD) and micro-spectroscopic methods (μFTIR and μRaman) will be provided, highlighting both their advantages and limitations. The study of the saponification processes will be also described within the experimental drying of model paints to reproduce and monitor both the reactions and the factors influencing or inhibiting the process (e.g., relative humidity, temperature, light, and so on).

References:
1. Hermans, J. J. et al. in 47–67 (2019)
2. Izzo, F. C. et al. ChemistryOpen 10, 904–921 (2021)

Adknowledgements: The research was supported by the following providers: Czech Science Foundation, project no. 17-15621S (principal investigator Dr. Petr Bezdička); Ministry of Culture of the Czech Republic, programme NAKI II, project no. DG18P02OVV034 (principal investigator: RNDr. Janka Hradilová); Academy of Science of the Czech Republic, Strategy AV 21, programmes 6 and 23 (responsible persons Ing. Silvie Švarcová, PhD. and Dr. David Hradil)

15)

Multi-text medieval manuscripts between textual criticism, codicology and paleography: the case of XV century manuscript Florence, Biblioteca Marucelliana, C 150, containing philosophical and rhetorical texts in vernacular Italian.

Paolo Divizia

Department of Romance Languages and Literatures, Masarykova univerzita, Brno, Czech Republic

When dealing with complex objects such as multi-text manuscripts, that is to say the most common form of book in the late Middle Ages and Renaissance, only a multidisciplinary approach that includes textual criticism, codicology, paleography and other field of studies (such as history of the language, history, source studies), can provide a historically aware understanding of the object itself, which quite often is the result of multilayered juxtapositions in a synchronic and diachronic way. The little known XV century manuscript preserved in Florence, Biblioteca Marucelliana, C 150, containing philosophical and rhetorical texts in vernacular Italian, will be used as case study in order to show how to untangle complex structures.

[keywords: manuscript studies, textual criticism, codicology, paleography, history of the language, history, literature]

16)

Giuliano de' Ricci reader of a lost work.

Ludovica Radif

Faculty of Arts, Department of Romance Languages, Palacký University

As a extremely nuanced and fascinating but also potentially close to our sensibilities. The beginning of the 16th century marks a turning point that I would call "authorial", with a hermeneutic maturity compared to the past, and it is precisely when the text we are discussing today is located. A borderline case that a philologist can come across. The soul and skeleton of his analyses are the manuscripts, be they part of a direct tradition or an indirect one, such as quotations, a manuscript (or printed text) that

at least partially reproduces the text. Nevertheless, in this case we are going to examine, we are not in such a situation, we do not possess any manuscript, but we do know one of his readers, who tells us about it. It deals with a very famous and important author on the European scene and a work that I am sure was very original and unique in the scenario of the time: author was Niccolò Machiavelli founder of political theory; the text is the lost comedy The Masks; the play was inspired by the ancient comedy of Aristophanes, something special in the context of his production. The Histories of Italian literature usually dedicate very few lines to that "literary failure". We certainly face a gap, but this gap in my opinion can be at least partially filled. It is not only the words expressed (in Biblioteca Nazionale Centrale di Firenze, MS Palatino, Grande Priorista a famiglie E.B. 14.1/I-IV: I, f. 160v) that are eloquent, but perhaps even more so what is kept silent. We must therefore consider Machiavelli as a not unremarkable representative of Aristophanes' revival, Fortleben, during the Renaissance.

17)

The evolution of political families in Central and Eastern Europe: Dynamics of electoral volatility and political orientation

Mattia Collini

Institute of Political Studies, Faculty of Social Sciences, Charles University, Prague, Czech Republic

Party politics in Central and Eastern Europe has been characterized by instability, fragmentation and volatility, at least when compared with the traditionally more stable Western Europe. However, are these phenomena affecting all in the same way or can we see some differences among 'blocs' or 'political families'? This question is particularly relevant in a time of political changes both in Eastern and Western Europe. This paper aims to be a comprehensive assessment of these phenomena, based on empirical evidence from the region. Blocs are a key aspect of the research, which explores how much the concept of 'bloc' can be applicable, and what are the main characteristics of old and new political families in CEE. Thus, the first goal of the paper is to present a comparative diachronic analysis of the electoral dynamics of political blocs/families in Central and Eastern Europe. The paper covers national elections in six Central and Eastern European countries (Czech Republic, Slovakia, Poland, Romania, Bulgaria, Hungary) from their democratic transition to 2020. This long timespan allows tracing the entire evolution of party systems and political families from their origin to the present days. Electoral volatility, (intra)bloc fragmentation, and political positions, are considered among the main variables to assess whether there are differences and/or recurring trends within the systems, as well as the emergence of newcomers. In particular, regression analyses will be used to search for correlations.

18)

The smoldering inflammation and the route to cancer.

Luca Vannucci[1], Fabián Čaja [1], Dmitry Stakheev [1,8], Pavol Lukác [1, 2], Lenka Rajsiglova [1, 2,] Paolo Tenti [1, 2], David Vondrašek [3], Gianluca Mucciolo [4], Paola Cappello [4], Renata Štěpánková [5], Peter Makovický [6], Pavol Makovický [7], Hana Kozáková [5], Petr Šima [1], Daniel Smerž [1,8]

1 Institute of Microbiology of the CAS, Prague, Czech Republic; 2 Faculty of Science, Charles University, Prague, Czech Republic; 3 Institute of Physiology of the CAS, Prague, Czech Republic; 4 University of Torino, Torino, Italy; 5 Institute of Microbiology of the CAS, Nový Hrádek, Czech Republic; 6 University of Ostrava,

Ostrava, Czech Republic; 7 J. Selye University, Komárno, Slovakia; 8 University Hospital Motol, 2nd Medical Faculty, Charles University, Prague, Czech Republic.

Chronic inflammation is recognized as a cancer-promoting factor. The full range of inflammatory processes is still under definition. Local changes of immune activation can induce fast collagen remodeling in the tissue. Reciprocally, collagen accumulation can affect the local immunity. We have shown that immunological activation of a tissue (by bacteria or chemicals) quickly modifies the colon mucosa structure. Using a rat model of chronic colitis (dextran sodium sulphate – DSS – induced colitis) and of carcinogenesis (azoxymethane – AOM - carcinogen for the colon) we have shown that, in both models, inflammation produce remodeling of the collagen scaffold, even when the mucosa appears recovered at the distance of 1 month from the acute induction. This occur dispite apparently normal o reduced levels of local cytokines as a smoldering inflammation. Immunological data and confocal microscopy suggest that normally the microbiota can elicit homeostatic regulation in the healthy rat colon mucosa. The modulation can be due to an "inflammatory threshold" establishing the range of tolerance toward the pro-inflammatory activation. The smoldering inflammation has dis-balance between pro-inflammatory and regulatory signals and, dispite low cytokine levels overcomes the inflammatory threshold. Underhand, smoldering inflammation is capable to continue to damaging the tissue structure and leading to either chronic inflammatory diseases or cancer development.
Acknowledgements: the work was supported by Institutional Grant RVO 61388971 (CZ), GAAV IAA500200917 (CZ), MEYS CR (Large RI Project LM2018129 Czech-BioImaging), ERDF (project No. CZ.02.1.01/0.0/0.0/18_046/0016045) and the project National Institute for Cancer Research (Programme EXCELES, ID Project No. LX22NPO5102) - Funded by the European Union –Next Generation EU, Generali Ceska Pojistovna Foundation (CZ), UniCredit Bank CZ & SK (CZ), CAMIC CZ, Eurinox s.r.o. (CZ), Fondazione CRT 2020.0719 (IT), SIAD s.r.o. (CZ), ARPA Foundation (IT).

19)

The different layers of pathological mechanosensing.

Stefania Pagliari, Marco Cassani, Soraia Fernandes, Francesco Niro, Monica Apostolico, Cristina Mazzotti, Carlo Sclavi, Enrico Di Iuri, Monica Feole, Victorio Pozo Devoto**, Giancarlo Forte[1, 2]**

[1]International Clinical Research Center (ICRC) of St. Anne's University Hospital, CZ-65691 Brno, Czech Republic; [2]School of Cardiovascular and Metabolic Medicine & Sciences, King's College London, London WC2R 2LS, UK.

The onset and progression of aging pathologies is highlighted by continuous extracellular matrix (ECM) transformation. ECM pathological remodeling results in dramatic changes in the chemistry, local stiffness, and nanostructure of the organ scaffold. Deposited by the tissue fibroblasts, the newly produced matrix displays impaired compliance and aberrant signalling, thus hinders cell functionality. The response of tissue cells to the ensuing biomechanical stress leads to the alteration of their transcriptional and post-transcriptional landscape, with the aim of preserving organ function (1).
Our group has tried to dissect the processes driving ECM remodelling and unveil the molecular pathways highlighting cell response to the new conditions. Cardiac disease represents a paradigmatic example of how ECM remodelling hinders cell functionality, here affecting muscle contractility and organ pumping function. Through human specimens and induced pluripotent stem cells, we identified reproducible modifications in the 3D nanostructure and mechanics of heart ECM that contribute to organ failure (2).
We found the hyperactivation of Hippo effector YAP in patient-derived cardiac fibroblasts promotes ECM pathological remodelling and favors the fibrotic process and fuels heart failure. Additionally, we

showed ECM maladaptive remodelling and YAP reactivation drive dramatic changes in cardiomyocyte transcriptional and post-transcriptional landscape to increase their contractility and preserve organ pumping function. We also highlighted how this process rewires the alternative splicing of numerous genes involved in cardiomyocyte contractility, calcium handling and mechanosensing (3).
ECM remodelling is also key to tumorigenesis, so that altered matrix stiffness is considered predictive of malignancies. We analyzed primary prostate cancer tissues obtained from patients undergoing radical prostatectomy to underline reproducible structural changes in the tumor ECM and promoting the loss of the glandular architecture. We established patient-derived prostate cancer tumoroids (PCTs) that mimic key features of the native tumor microenvironment (TME) and proceeded to investigate the cooperative role of TGF-β signalling and ECM *desmoplasia* in fostering tumor progression and dissemination (4).
REFERENCES: 1. Pesce M et al. *Nat Rev Cardiol 2022; 20:309-324; 2.* Perestrelo AR et al. *Circ Res 2021; 128:24-38*; 3. Martino F et al. *Sci Trans Med 2022;14: eabo5715*; 4. Fernandes S *et al*. *Biorxiv 2023; 10.1101/2023.04.03.534859*

20)

An induced pluripotent stem cell-based model to study the role of EXTRACELLULAR MATRIX in myocardial fibrosis.

***Francesco Niro*[1,2]*, Soraia Fernandes*[1]*, Marco Cassani*[1]*, Jorge Oliver-De La Cruz*[1]*, Daniel Pereira-Sousa*[1,2]*, Stefania Pagliari*[1]*, Vladimir Vinarsky*[1,2]*, Monica Apostolico*[1]*, Giulio Pompilio*[3]*, Elena Sommariva*[3]*, Davide Rovina*[3]*, Giancarlo Forte*[1,2,4]

1 International Clinical Research Center, St. Anne's University Hospital Brno, Brno, Czech Republic;
2 Department of Biomedical Science, Faculty of Medicine, Masaryk University;
3Centro Cardiologico Monzino-IRCCS, Unit of Vascular Biology and Regenerative Medicine, Milan, Italy;
4 School of Cardiovascular and Metabolic Medicine and Sciences, King's College London, UK.

Cardiac fibrosis is the consequence of chronic insults to the myocardium, characterized by the abnormal accumulation of extracellular matrix (ECM). Differentiation of cardiac fibroblasts (cFbs) into myofibroblasts drives the pathological ECM remodelling, a process highlighted by biochemical and structural changes which compromise cardiomyocyte (CMs) activity and lead to heart failure. Here, we adopted induced pluripotent stem cells (iPSCs) to investigate how fibrotic ECM affects CMs pathophysiology. We derived cFbs from induced pluripotent stem cells (iPSCs-cFbs) and optimized a protocol to differentiate them into myofibroblasts based on the fine-tuning of bFGF and TGF-β1 signalling pathways. Next, we obtained ECM by implementing a decellularization procedure of either quiescent or activated iPSCs-cFbs and analyzed the pathological changes occurring during the deposition of diseased cardiac ECM. Then, we developed iPSCs-CMs and cultured them on healthy or fibrotic decellularized ECM (dECM). Flow cytometry was adopted to study how the biomechanical properties of dECM affect CMs phenotype. We further validated our model using iPSCs-CMs derived from Duchenne muscular dystrophy (DMD) cardiopathic patients. By capitalizing on this approach, we might be able to recapitulate the accumulation of fibrotic tissue during heart diseases and investigate the contribution of pathological ECM to the progression of many cardiac disorders. Indeed, dECM derived from cFbs (dECM-cFbs) represents a bio-inspired scaffold for iPSCs-CMs culture, proposed as an animal-free, isogenic model of cardiac fibrosis for personalized medicine applications. *Adknowledgements: This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 860715. The material presented and views expressed here are the responsibility of the author(s) only. The EU Commission takes no responsibility for any use made of the information set out.*

21)

Primordial proteins: simple but not simpler

Valerio Guido Giacobelli and Klara Hlouchova

Department of Cell Biology, Faculty of Science, Charles University, Prague, Czech Republic

All extant cells known to humankind build proteins from the same 20 coded amino acids. However, the study of origins of life implies that earlier cells functioned with a smaller alphabet, before the fixation of the Central Dogma. This profound evolutionary transition in our cells' history therefore raises urgent questions: how could early proteins support a proto-biosphere and how easy or hard is it to build a functional protein from a prebiotically plausible alphabet?
I will uncover the properties of proteins from an early subset of the canonical amino acids and additionally, the effects of selected unnatural (prebiotically plausible) amino acid incorporation will be elaborated. Besides the impact of different amino acid alphabets on the peptide/protein biophysical properties, we have inspected the capacities of prebiotically plausible sequences to bind RNA as representatives of their early functional potential.
Our work indicates that structured conformations were readily available already to early protein alphabets, capitalizing on interactions that are less frequent or rare in today's biology. In addition, we have identified factors which have likely contributed to the selection of the canonical alphabet from the prebiotically plausible alternatives.

22)
Applications and development at IPHYS Bioimaging facility

Basello Davide, Hadraba Daniel

Bioimaging facility, Institute of Physiology of the Czech Academy of Sciences, Prague, Czech Republic

The IPHYS facility provides an extensive light microscopy and data analysis service. The facility belongs to the Czech-Bioimaging infrastructure and actively participates in Prague Node – EuroBioimaging. It participated in research areas such as confocal microscopy, label-free microscopy, correlative microscopy or stereology. The activities of facility will be presented on two selected examples covering Cajal body formation (Davide Basello) and the development and integration of STED modality into the existing customized Bruker Ultima microscope (Daniel Hadraba).
Adknowledgements: The project was supported by MEYS (LM2023050 Czech-BioImaging).

23)

Development of a new optogenetic brain-on-a-chip approach to study GABA/NMDAR altered ratio in Schizophrenia.

Enrico Patrono

Laboratory of Neurophysiology of Memory, Institute of Physiology of the Czech Academy of Sciences, Prague, Czech Republic

Schizophrenia affects about 1% of the worldwide population and includes impaired decision-making and cognitive inflexibility. These dysfunctions are due to an unbalanced excitation/inhibition in the neural transmission of the prefrontal cortex and the hippocampus. GABA is an inhibitory neurotransmitter, while NMDAR is a glutamatergic receptor involved in cognitive processing. Optogenetic stimulation of GABA showed to be effective in re-establishing excitatory/inhibitory balance. Although animal models study in vivo brain physiology, the real-time observation of neural circuits is hampered by the low accessibility to deeper areas. The fabrication of nanofluidic chips advanced innovative in vitro-silico models for neural circuits (brain-on-a-chip, BoC), allowing a high-level time/space resolution. Within the 3Rs concept, neural systems built on microchips allow a significant leap forward in developing human-relevant brain models of pathologies. The following logical step is to integrate the optogenetics technique with a BoC, exploiting the high target reliability of optogenetics.

24)

Deletion of beta2-containing nicotinic acetylcholine receptors in striatal interneurons controls striatal-dependent behaviors.

Abbondanza Alice[1,5], Capek M.[2,3], Dumas S.[4], Bernard V.[5], Janickova H.[1]

[1] Department of Neurochemistry, Institute of Physiology, Czech Academy of Sciences, Prague, Czech Republic
[2] Laboratory of Biomathematics, Institute of Physiology of the Czech Academy of Sciences, Prague, Czech Republic
[3] Light Microscopy Core Facility, Institute of Molecular Genetics of the Czech Academy of Sciences, Prague, Czech Republic,
[4] Oramacell, Paris, France
[5] Neuroscience Paris Seine, Sorbonne Université - CNRS UMR 8246, Paris, France

The importance of cholinergic signaling in the striatum for behavioral control and cognition has been extensively studied, but little is known about the functional role of nicotinic acetylcholine receptors (nAChRs) expressed by local neurons. The principal striatal neurons, the medium spiny neurons (MSNs), express only very low levels of nAChRs, hence the vast majority of nAChRs are expressed by striatal interneurons (INs), either cholinergic (CINs) or GABAergic (GABAINs), that overall represent less than 5% of the striatal population. We hypothesize that acetylcholine released by CINs activates nAChRs expressed by CINS themselves and GABAINs and that this activation is important for modulating striatal-based behavior.
At first, we used double fluorescent in situ hybridization (FISH) targeting the most prevalent nicotinic subunit, beta2, in combination with markers identifying CINs or GABAINs, to define which neuronal types express nAChRs, in the mouse striatum. To determine the functional role of strital nAChRs, we deleted beta2 nicotinic subunit by injecting Cre-expressing AAV viral vector into the dorsal striatum of beta2-flox/flox mice, which we tested in a battery of behavioral tasks. Mice with deletion of beta2* nAChRs showed increased anxiety-like behavior, together with a decrease in sociability ratio and a deficit in discrimination learning. As last task before sacrificing the animals, we tested the sensitivity to a stimulant drug, amphetamine, and analyzed the expression of a neural activity marker, c-Fos, in the dorsal striatum. The deletion of beta2* nAChRs increased amphetamine-induced hyperlocomotion along with c-Fos expression in MSNs and in striatal INs.
We conclude that beta2-containing nAChRs are primarily expressed by CINs in the striatum and that, even if in a small number, they modulate striatal signaling and striatal-based behavior.
Adknowledgements: This work was supported by the Grant Agency of the Czech Republic Grant #19-07983Y.

25)

Assessing the non-linearity in brain data across modalities.

Giulio Tani Raffaelli, S. Jiříček, J. Hlinka

Complex Systems Department, Computer Science Institute, Czech Academy of Sciences, Prague, Czech Republic

Resting-state fMRI functional connectivity (RSFC) is a technique used in neuroimaging to assess the functional connectivity between different brain regions while the subject is at rest. We can use RSFC to study the brain's intrinsic functional architecture and to investigate how brain regions communicate. For example, RSFC is useful in the study of several neuropsychiatric disorders, including epilepsy, depression, and schizophrenia. The most common way to estimate functional connectivity is Pearson's correlation of the BOLD signal between region pairs. However, correlation can account correctly only for linear dependences. In the last ten years, scholars proposed alternative methods for the estimation to address the limitations of correlation. One of the most adopted is the information-theoretic measure of Mutual Information. For infinite time series, MI can account for any possible pairwise interaction between the time series. Yet, in applications, the time series' length is limited by technical and conceptual reasons. We investigate the actual power of MI approaches on different brain data varieties. We go beyond functional connectivity exploring the amount of non-linearity observable in the brain, from fMRI data to EEG and iEEG. By comparing different MI estimators and correlation, we can learn some lessons about the actual usefulness of the newly proposed approaches.

26)

Vaccine Hesitancy and Medical Specialists

Dino Numerato

Department of Sociology, Faculty of Social Sciences, Charles University, Prague, Czech Republic

Healthcare professionals represent one of the most influential groups of actors in childhood vaccination programmes. While recent social scientific scholarship focused its primary attention on the role of paediatricians (e.g., Deml 2020; Leask et al. 2012; Lehner et al. 2022), including vaccine-hesitant healthcare professionals (MacDonald, & Dubé 2015; Verger et al. 2015, 2016), the role of medical specialists remained unexplored. Against this backdrop, this contribution aims to systematically explore the varieties of involvement of medical specialists in childhood vaccination. More specifically, this contribution addresses the following questions: When do the parents and paediatricians address medical specialists concerning vaccination? What is the role of medical specialists concerning vaccination? How do paediatricians approach medical specialists? This study draws on ethnographic observations and semi-structured interviews with healthcare professionals in the Czech Republic, where childhood vaccination is mandatory. Four ideal-typical forms of interactions between paediatricians and medical specialists were identified, in particular, a) uncritical reliance on medical specialists, b) problematization of the role of medical specialists, c) contestation of medical specialists and d) the recognition of complexity, understanding and reflexive approach. Furthermore, the study suggests that the interactions between paediatricians and medical specialists contribute to negotiating and reproducing existing professional identities.