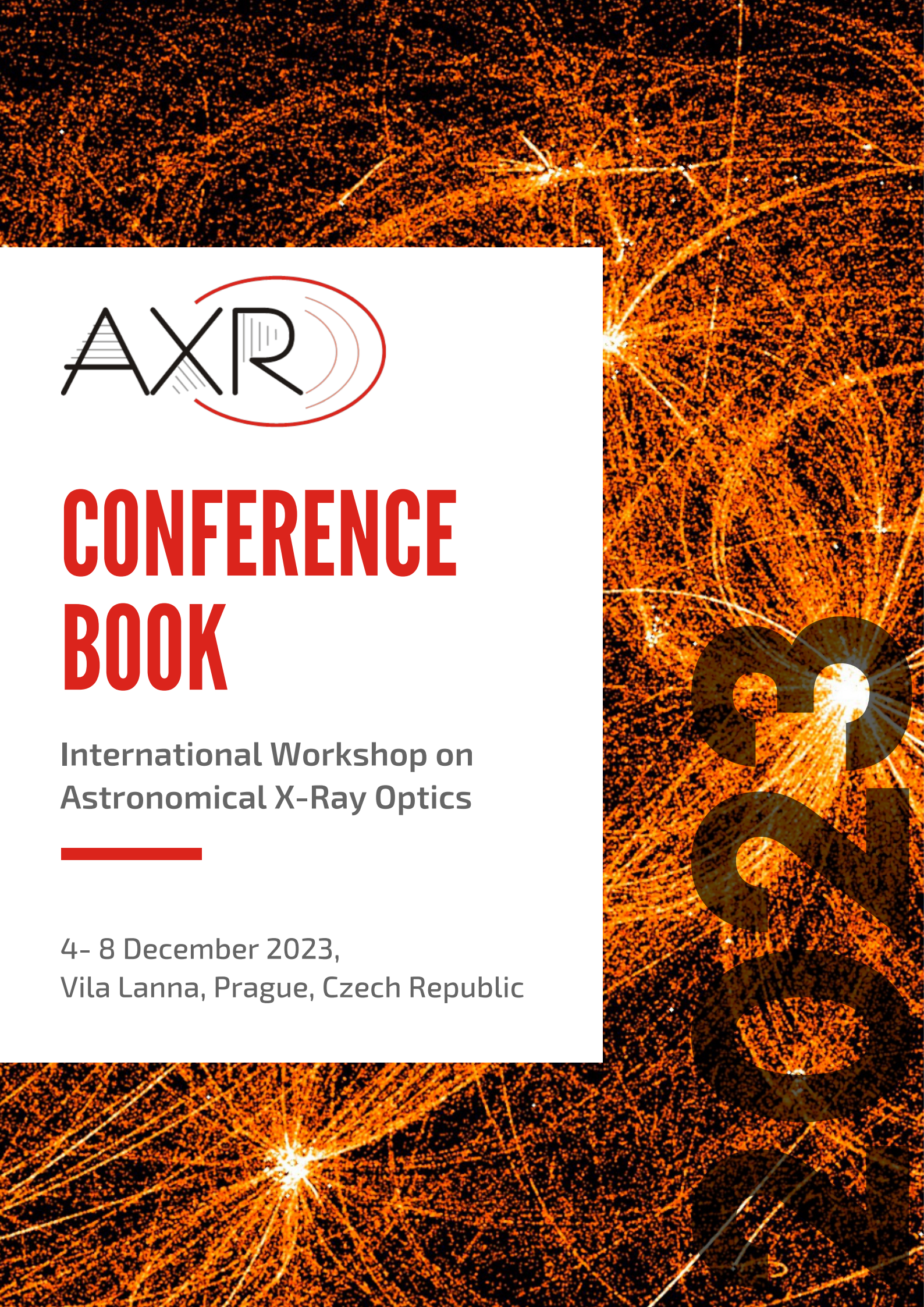

CONFERENCE BOOK

International Workshop on Astronomical X-Ray Optics

4- 8 December 2023,
Vila Lanna, Prague, Czech Republic

The open LaTeX template, AMCOS_booklet, used to as template for this booklet is available at

https://github.com/maximelucas/AMCOS_booklet

Prepared by Martin Urban for AXRO conference/workshop.
https://www.axro.cz

Contents

About

International Workshop on Astronomical X-Ray Optics

AXRO is International Workshop on Astronomical X-Ray Optics focused on the presentation and discussion of recent and future technologies for future X-ray astronomy missions. One session is focused on astrophysical aspects of X-ray telescopes/satellites, where some review talks are typically given by leading scientists in this field, plus some presentations of relevant Czech scientists. Sessions focusing on all aspects of astronomical X-ray optics, X-ray detectors and test facilities are an essential part of the AXRO conference as well. Last but not least, recent and future X-ray space missions are also presented and discussed.

The goal of the workshop is to present and discuss recent and future technologies for X-ray astronomy missions. These missions require the development of the most innovative technologies, and we would like to discuss in detail the possibilities, the results obtained so far, and new ideas. It is obvious that the requirements of future large space X-ray astronomy missions are so demanding that they need a truly interdisciplinary approach in a broad international collaboration. These technologies will include X-ray optics based on Si wafers, advanced glass forming for precise X-ray optics, but also other possible technologies and alternatives, as well as related advanced metrology, measurements and tests.

Albeit the conference is focused on astronomical X-ray optics, we also invite participants from X-ray communities outside astronomy, as many aspects, such as designing, manufacturing, and testing X-ray optics, are similar for both communities, so sharing experience can be beneficial for all.

This year's held the 14th International Workshop on Astronomical X-Ray Optics.

Organising committee

Veronika Maršíková	Rigaku Innovative Technologies Europe s.r.o.
Martin Urban	Czech Technical University in Prague
Ondřej Nentvich	Czech Technical University in Prague
René Hudec	Astronomical Institute of the Czech Academy of Sciences & Czech Technical University in Prague

Scientific committee

René Hudec	Astronomical Institute of the Czech Academy of Sciences & Czech Technical University in Prague
John Nousek	The Pennsylvania State University
Peter Predehl	Max Planck Institute for Extraterrestrial Physics
Vadim Burwitz	Max Planck Institute for Extraterrestrial Physics
Richard Willingale	University of Leicester
William Zhang	NASA Goddard Space Flight Center
Ladislav Pina	Rigaku Innovative Technologies Europe s.r.o.
Randall McEntaffer	The Pennsylvania State University
Thorsten Döhring	Technische Hochschule Aschaffenburg
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CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

asu Astronomical Institute of the Czech Academy of Sciences

AHEAD 2020

Funded by the Horizon 2020 Framework Program of the European Union Grant Agreement No. 871158

Rigaku Leading With Innovation

OHB CZECHSPACE

Topics

AST X-ray Astrophysics

This session is focused on the astrophysical aspects of X-ray telescopes/satellites. Contributions from all fields of X-ray astronomy and astrophysics are invited here, both experimental as well as theoretical, especially those with relation and/or impact on space X-ray telescopes. The main focus of this section is on potential X-ray sources for use in X-ray astronomy using telescopes and satellites.

OPT X-ray Optics

Presentations discussing technologies for future space X-ray astronomy missions are encouraged. These missions require the development of most innovative technologies; the possibilities, the results obtained so far and details of new ideas are suitable topics for discussion. The recent situation in the field strongly demonstrates the urgent need for novel, cost-effective approaches and solutions.

MIS X-ray Missions

This session will include presentations of recent as well as new and future space missions and related scientific payloads with the focus for X-ray domain. Contributions from all categories of satellites and space missions are welcome (like L-class, M-class as well as S/F-class). Presentations of current, new results as well as proposals for new missions are very welcome.

DET X-ray Detectors & Test Facilities

Contributions regarding detectors and facilities suitable for use in X-ray are very welcome. New methods and principles of detection can be presented as well as existing solutions and their improvements. Facilities their testing method and measurement options, along with exciting results, can be presented in this section as well.

Icons

 **Ahead 2020**

 **Talk**

 **Poster**

Time schedule

Monday, 4 December

13:45–14:15	**Registration**		

AHEAD Session chair: Rene Hudec

14:15–14:25		**Rene Hudec**	Opening workshop and Welcome notes
14:25–15:10	**AST**	**Franco Giovannelli**	The History of High Energy Experiments: from UHURU to IXPE
15:10–15:40	**OPT**	**Vadim Burwitz**	AHEAD2020: development and testing X-ray optics
15:40–16:00	**Coffee break**		

AHEAD Session chair: Peter Predehl

16:00–16:30	**OPT**	**Rene Hudec**	Czech Contribution to AHEAD: Novel Lobster Eye and Kirkpatrick Baez X-ray Optics Modules
16:30–17:00	**OPT**	**Daniele Spiga**	Enhancing X-ray Mirror Performance with Carbon Dip-Coatings

19:00–23:00	**Welcome reception**

Last updated on November 24, 2023 at 19:45 CET.

Tuesday, 5 December

09:15–09:30	**Registration**		

AHEAD Session chair: Rene Hudec

	Opening workshop and Welcome notes		
09:30–09:40		**Michal Bursa**	Director of Astronomical Institute
09:40–09:50		**Zbyněk Škvor**	Vice-Rector of the Czech Technical University in Prague
09:50–10:00		**Karel Dobeš**	Government Commissioner for EU Agency for the Space Programme
10:00–10:15		**Rene Hudec**	AXRO introduction and historical background
10:15–10:30	**Coffee break**		

AHEAD Session chair: Randall McEntaffer

10:30–10:50	**OPT**	**Vladimír Tichý**	LOPSIMUL extra fast ray-tracing software
10:50–11:10	**DET**	**Daniele Spiga**	Advancement and future perspectives of BEaTriX
11:10–11:30	**OPT**	**Alex Bayerle**	Athena's X-ray mirror based on silicon wafers – advances in silicon pore optics manufacturing
11:30–11:50	**OPT**	**Ondřej Nentvich**	Data processing for all-sky monitoring based on Lobster-eye optics
11:50–13:10	**Lunch**		

AHEAD Session chair: Daniele Spiga

13:10–13:30	**OPT**	**Vladimír Tichý**	Tests of Schmidt lobster eye based on new technology
13:30–13:50	**OPT**	**Yanji Yang**	Develpment of the Focusing Mirror in IHEP
13:50–14:20	**OPT**	**Wayne Baumgartner**	Full-Shell Replicated X-ray Optics at MSFC
14:20–14:40	**OPT**	**Veronika Stieglitz**	
14:40–14:55	**Coffee break**		

Session chair: Herman Marshall

14:55–15:15	**OPT**	**Danielle Gurgew**	Thin film coating capabilities for X-ray optics at NASA Marshall Space Flight Center
15:15–15:35	**OPT**	**Jake McCoy**	Fabrication of a large-format blazed grating with radial grooves
15:35–16:00	**OPT**	**Fabien Grisé**	Fabrication of gratings on curved substrates using electron-beam lithography
16:00–16:15	**Coffee break**		

Session chair: John Nousek

16:15–16:45	**OPT**	**Frank Siewert**	Gratings for the soft- and tender-X-ray energy range - recent developments at Helmholtz Zentrum Berlin
16:45–17:30	**OPT**	**Randall McEntaffer**	The Off-plane Grating Rocket Experiment: international synergies for high-performance spectroscopy

18:00–22:00	**Social Dinner**

Last updated on November 24, 2023 at 19:45 CET.

Wednesday, 6 December

09:20–09:30	**Registration**		

AHEAD Session chair: Frank Siewert

09:30–10:00	**OPT**	**Alexandra Higley**	Early Results from Characterization of JET-X, Polished Silicon Optics and Off-Plane Reflection Gratings at the PANTER X-ray Test Facility
10:00–10:20	**OPT**	**Herman Marshall**	Steps Toward Milli-Arcsecond X-ray Astrophysical Imaging
10:20–10:40	**Coffee break**		

AHEAD Session chair: Michal Zajaček

10:40–11:25	**AST**	**Franco Giovannelli**	The Impact of Space Experiments on the Knowledge of Our Universe
11:25–11:45	**AST**	**Martin Jelínek**	Search for common features in GRB optical and X-ray lightcurves
11:45–12:15	**AST**	**Daniele Fargion**	X Rays burst and flare in space from the Earth Horizons
12:15–13:35	**Lunch**		

Session chair: Vadim Burwitz

13:35–13:55	**MIS**	**Lorenzo Natalucci**	Status of the AHEAD2020 Program
13:55–14:15	**MIS**	**John Nousek**	Flying Swift for 20 Years
14:15–14:40	**MIS**	**Peter Friedrich**	Investigations of the eROSITA "light leak"
14:40–15:00	**Coffee break**		

Session chair: Vladimir Dániel

15:00–15:30	**MIS**	**Vojtech Simon**	X-ray observing the cosmic sources by the ESA–CAS satellite SMILE
15:30–15:55	**MIS**	**Norbert Werner**	QUVIK - Quick Ultra-Violet Kilonova surveyor
15:55–16:15	**MIS**	**Enrico Virgilli**	The XGIS instrument in the context of the THESEUS ESA M7 mission candidate
16:15–16:35	**Coffee break**		

Session chair: Filip Münz

16:35–16:55	**MIS**	**Lorenzo Natalucci**	GRINTA, an explorer of the transient sky
16:55–17:20	**MIS**	**Maxim Markevitch**	Line Emission Mapper - an X-ray Astrophysics Probe to reveal the hidden drivers of galaxy growth
17:20–17:45	**MIS**	**Herman Marshall**	Rocket Experiment Demonstration of a Soft X-ray Polarimeter (REDSoX)

17:45	**End of day**

Last updated on November 24, 2023 at 19:45 CET.

Thursday, 7 December

Session chair: Peter Friedrich

09:30–09:50	DET	**David Hladik**	Optimizing the Timepix2 Hybrid Pixel Detector: An In-Depth Exploration of Detector Performance for Scientific and Industrial Applications
09:50–10:10	DET	**Martin Urban**	Timepix3: Temperature Effects on Radiation Energy Measurements
10:10–10:30	DET	**Filip Münz**	Performance of detectors on GRBAlpha and VZLUSAT-2 nanosatellite missions
10:30–10:50	**Coffee break**		

Session chair: Dan Schwartz

10:50–11:30	AST	**Konrad Dennerl**	SRG/eROSITA and the first ever clear view of the soft diffuse X-ray sky
11:30–12:05	AST	**Peter Predehl**	The X-ray Bubbles at the Galactic Center
12:05–13:25	**Lunch**		

Session chair: Jiri Svoboda

13:25–13:55	AST	**Michal Zajaček**	Nuclear X-ray outbursts every 22 days
13:55–14:20	AST	**Gabriel Török**	Modulation mechanism of twin-peak quasi-periodic oscillations in neutron star X-ray binaries
14:20–14:45	AST	**Norbert Werner**	Multi-phase gas, accretion and jet power in early-type galaxies

15:00–22:00	**Social Event**

Last updated on November 24, 2023 at 19:45 CET.

Friday, 8 December

Session chair: Konrad Dennerl

09:30–10:00	**AST**	**Jiri Svoboda**	X-ray polarimetry view of stellar-mass accretion black holes
10:00–10:20	**AST**	**Vladimir Karas**	On particle acceleration near a magnetized rotating black hole
10:20–10:40	**AST**	**Dan Schwartz**	Synoptic Astrometry of the lensed Quasar HE0435-1223: X-ray Varstrometry
10:40–11:00	**AST**	**Maïmouna Brigitte**	Multiwavelength and X-ray polarimetric observations of the high-mass X-ray binary Cygnus X-1 during May 2023
11:00–11:15	**Coffee break**		

11:15–11:35	**Franco Giovannelli**	Concluding Remarks
11:35–11:55	**Rene Hudec**	Concluding address

12:00–13:00	**Lunch**

13:00	**End of workshop**

Last updated on November 24, 2023 at 19:45 CET.

Full-Shell Replicated X-ray Optics at MSFC

Wayne Baumgartner
NASA Marshall Space Flight Center, United States

The fabrication of full-shell replicated X-ray optics is a standard technology for producing astrophysical X-ray telescopes like XMM, eRosita, and IXPE. Until recently, the angular resolutions of space-borne observatories has been in the range of 14-20 arcseconds, limited primarily by polishing, manufacturing, and assembly tolerances. We have embarked on a research program at MSFC to improve the angular resolution of full-shell replicated optics by employing new polishing techniques using a Zeeko deterministic polisher, as well as improving the precision of the assembly of the mirror shells into a complete module. We present results from a R/D program associated with the FOXSI balloon-borne hard X-ray solar telescope that incorporate these polishing, assembly, and testing improvements and have delivered three flight modules with two shells in each module. Initial results from beamline module testing show an angular resolution of 9 arcseconds HPD (3 arcs FWHM) without removing the effects of gravity on the measured performance. With further analysis to remove the gravity distortion, we expect to achieve performance results of 5-7 arcseconds HPD for these optics.

Athena's X-ray mirror based on silicon wafers – advances in silicon pore optics manufacturing

OPT

Alex Bayerle
cosine measurement systems B.V, Netherlands

The segmented mirror of the x-ray observatory Athena will consists of hundreds of mirror modules based on silicon pore optics (SPO), that cosine and partners are developing. Each SPO module is a focusing segment of the Wolter-Schwarzschild design and will be integrated in Athena's 2.5-m diameter mirror structure. This modular approach allows for an unprecedented product between collection area and resolution. The goal for Athena's mirror is to achieve an effective area of 1.4m^2 and a resolution of sub-10" half-energy width at a photon energy of 1 keV. Manufacturing hundreds of modules is enabled by semiconductor wafer technology. Each module consists of up to 152 silicon wafer mirror plates. Our raw material, 300-mm silicon wafers have excellent properties for being turned into x-ray mirror modules, such as sub-nm surface roughness and thickness variations below 100 nm. We employ a range of semiconductor manufacturing processes to create mirror plates from wafers, such as dicing, lithography patterning, coating. Then custom machines produce the modules in an automatic way by stacking the mirror plates on top of each other. SPO has also shown to be a versatile technology that can be further developed for gamma-ray optics and medical applications. This paper will present the status of the technology and of the mass production capabilities, show latest performance results and discuss the next steps in the development.

AHEAD2020: development and testing X-ray optics

OPT

Vadim Burwitz
Max-Planck-Institut for Extraterrestrial Physics, Germany

An overview of the results and progress of the work on the development and testing of X-ray optics supported by the AHEAD2020 project funded by the European Union Horizon 2020 research and innovation program will be presented. The work presented ranges from testing optics for upcoming flight missions such as SVOM and Einstein Probe to the development and testing of novel optics for future missions such as NewAthena. Furthermore, the development of X-ray optic test facilities such BEaTriX for silicon pore optics and the VTF for micropore optics was supported. Also, new types of optic like the Kirk-Patrick Baez optics, were developed and tested, like most of the other X-ray optics, at the PANTER X-ray test facility of the Max Planck Institute for Extraterrestrial Physics.

Fabrication of gratings on curved substrates using electron-beam lithography

Fabien Grisé
The Pennsylvania State University, United States

The next generation of reflection gratings for future high-energy space observatories needs a high degree of customization. Making such gratings will require the use of increasingly complex nanofabrication techniques. One of the current challenges we are investigating is the precise patterning of grooves onto curved substrates, which is needed for effective aberration-correction. We report on our use of electron-beam lithography to pattern moderate-format gratings on cylindrical substrates. We will discuss the fabrication steps involved, from the alignment of the substrate to the actual writing strategy, and we will summarize our characterization efforts based on interferometric measurements. Future steps will be discussed, including the patterning of a segmented X-ray mirror.

Thin film coating capabilities for X-ray optics at NASA Marshall Space Flight Center

Danielle Gurgew
Universities Space Research Association, United States

Alongside the development of high resolution, full-shell replicated X-ray optics, MSFC is also pursuing the development of advanced thin film coatings. Current direct deposition methods for full shell coatings involve a radio frequency (RF) sputtering system with a wire-like target that slowly deposits a single layer of metal on the inner surface of the shell. As coating designs become more complex, a new method of direct deposition is required. Due to the promising results of on-going hard X-ray multilayer development at Marshall, recent funding has been granted to procure a new DC magnetron deposition system to directly deposit multilayer coatings onto the reflective surface of full shell optics. This new system will vastly expand MSFC's coating capabilities for full shell optics to include bilayer and multilayer coated designs. The design of this new system and its applications for future hard X-ray missions such as SuperHERO, with be presented and discussed.

Early Results from Characterization of JET-X, Polished Silicon Optics and Off-Plane Reflection Gratings at the PANTER X-ray Test Facility

OPT

Alexandra Higley
The Pennsylvania State University, United States

The PANTER X-ray Test facility is a 130m long vacuum tube located in Neuried, Germany that is used to produce forefront characterization of next generation X-ray optics. We present early results from a six-week long campaign to characterize high-resolution X-ray technology such as mono-crystalline silicon optics which have planned use on several proposed NASA X-ray Explorer and Probe missions, as well as off-plane reflection gratings which serve as an option to achieve the spectral resolution requirements of a Lynx-like flagship mission. Additionally, the second flight module of the Joint European Telescope for X-ray astronomy (JET-X FM2) was re-tested to follow up on a characterization study of the instrument performed in 2012 at the same facility. This campaign demonstrates near-equivalent effective area and angular resolution measurements of the JET-X optic after a decade of storage, while also demonstrating the ability of a mono-crystalline silicon double-shell mirror assembly and aberration correcting, blazed reflection gratings. Results confirm the high-resolution performance of polished silicon optics as well as the high-resolution, high-efficiency performance of the diffraction gratings.

Czech Contribution to AHEAD: Novel Lobster Eye and Kirkpatrick Baez X-ray Optics Modules

OPT

Rene Hudec
ASU AV CR & CTU, Czech Republic

We present Czech contribution to AHEAD with emphasis on the innovative Lobster Eye (LE) and Kirpatrick Baez (KB) modules based on Multi Foil Optics technology (MFO). The LE X- ray optics is a wide field of view (FOV) optics type Lobster Eye (LE) with short focal length (suitable for cubesat application) based on Schmidt design. The 2D LE optics consists of two orthogonal sub-modules of flat smooth reflective foils and each sub-modules focuses in one direction. The advantage of MFO LE is that for off-axis points the angular resolution is preserved throughout the FOV, as demonstrated by simulations and measurements. The detector system includes two detectors - Timepix3 Quad and spectroscope. The benefit of the combined detector system was demonstrated in the real measurement. The KB modules developed and tested include a double test module HORUS as well as a new generation multiple arrays module of 2D X-ray KB optics with long f (nearly 6 meters).

Steps Toward Milli-Arcsecond X-ray Astrophysical Imaging

OPT

Herman Marshall
MIT Kavli Institute, United States

We have started two newly funded programs to push beyond sub-arcsecond toward mili-arcsecond X-ray imaging for astronomy. One method is based on normal incidence, multilayer coated optics. This method is based on extending advances in EUV lithography up to 250 to 500 eV. The new ellipsoidal optic will be tested for performance before coating interferometrically and then after coating in an X-ray beam line. In this case, conventional Cassegrain optical design is planned for a flight system. In the second method, we will test metrology methods needed for X-ray interferometry at grazing incidence. A novel optical design has been developed and will be tested in a small X-ray beam line within the next few years.

Fabrication of a large-format blazed grating with radial grooves

OPT

Jake McCoy
The Pennsylvania State University, United States

Future soft x-ray spectrometers that use reflection grating technology typically call for arrays of custom gratings to be integrated into a Wolter-type telescope, where they intercept and disperse radiation coming to a focus over several meters. To enable both high spectral sensitivity and high spectral resolving power simultaneously, each grating requires blazed groove facets patterned over an aberration-correcting layout, such as a fanned, or “radial”, profile that matches the telescope focal length. A large-format master grating that meets such specifications with blazed, radial grooves has been fabricated at the Penn State Materials Research Institute and tested for spectral resolving power at the PANTER X-ray Test Facility of the Max Planck Institute. This presentation describes how the grating was fabricated using the electron-beam process of thermally-activated selective topography equilibration (TASTE), which has the key advantage of producing blazed groove facets in polymeric resist over a non-parallel groove layout not limited by substrate crystal structure. Additionally, preliminary resolving power results are presented along with diffraction-efficiency models supported by previous synchrotron testing at the Advanced Light Source of Lawrence-Berkeley National Laboratory.

OPT

The Off-plane Grating Rocket Experiment: international synergies for high-performance spectroscopy

Randall McEntaffer
the Pennsylvania State University, United States

The Off-plane Grating Rocket Experiment is a NASA suborbital rocket payload for high-performance X-ray spectroscopy. It consists of a Wolter-type telescope, reflection grating array, and CCD camera. This talk will discuss the various synergies this project has created with international partners. The camera was fabricated at XCAM (UK) with collaboration with the Open University. The JET-X telescope will be provided by the Italian Space Agency and used in a pathfinder mission. The gratings will be replicated in the Netherlands at SCIL Nanoimprint Solutions and with wafers prepared at Micronit and stacked at cosine using the same technology developed for Athena's silicon pore optics. Finally, the components are performance tested at Max Planck's PANTER test facility. These significant contributions from European partners are enabling a successful program for high-performance spectroscopy.

OPT

Data processing for all-sky monitoring based on Lobster-eye optics

Ondrej Nentvich
Czech Technical University in Prague, Czech Republic

The results of my PhD thesis cover two parts related to lobster-eye optics. The first part focuses on the newly developed ray tracing simulator PyXLA, which is mainly designed to verify the properties of 1D or 2D Lobster-Eye optics in Schmidt or Angel arrangement with a custom X-ray detector. Since the X-ray sky is rich in transient, variable and flaring triggers, it is possible to include a theoretically unlimited number of sources to reflect the real situation that the instrument is supposed to observe.

A feasibility study is presented to locate point sources from two 1D Lobster-Eye optics. This task is based on a gap created by the coded mask that determines the direction of an incoming beam with a combination of main line focus. The proposed algorithm is mainly aimed at finding maxima and minima and based on their mutual position it is possible to determine the location of the sources.

Gratings for the soft- and tender-X-ray energy range - recent developments at Helmholtz Zentrum Berlin

Frank Siewert
Helmholtz Zentrum Berlin / BESSY-II, Germany

High quality diffraction gratings are key-optical elements in photon-science at accelerator-based photon-sources like Synchrotron-storage rings and Free Electron Lasers (FEL) as well as in astrophysics e.g. for satellite-based X-ray-spectrometers and -telescopes. We will report on recent developments at Helmholtz Zentrum Berlin to provide blazed gratings based on a new technological approach to "write" such gratings by means of e-beam lithography. In addition we will show how the use of ML-coatings allows to extend the photon-energy range achievable with reflection gratings towards the tender-X-ray energy range up to 8 keV potentially. This presentation will discuss results of ex-situ and at-wavelength metrology to verify the process of grating production. Finally we will also show first results of proof-of-principle-experiments of X-ray-spectro-microscopy in the tender-X-rays up to photon energies of 3 keV realized at the U41-PGM Transmission X-ray Microscopy (TXM) beamline at the BESSY-II-storage-ring in Berlin.

TBD

Veronika Stieglitz

TBD

Enhancing X-ray Mirror Performance with Carbon Dip-Coatings

Daniele Spiga
INAF - Brera Astronomical Observatory, Italy

In the past years, we have experimented with novel carbon coatings obtained by dip-liquid deposition to optimize the soft X-ray reflectivity response. In this work, we present the advancement in our research on innovative coatings, including results about thickness optimization. Our experiments show that dip-liquid deposition produces coatings which can significantly improve the reflectivity of X-ray mirrors in the soft X-ray band. Moreover, we have tested these coatings on realistic optical models and obtained considerably higher reflectivity than traditional metallic coatings. Finally, we discuss the potential applications of these new coatings on optics for future space missions, like ATHENA and eXTP.

LOPSIMUL extra fast ray-tracing software

Vladimír Tichý
Vladimír Tichý, Czech Republic

Presentation of LOPSIMUL ray-tracing simulation software that offers extremely high computational rate. LOPSIMUL has not a specific requirements for computer hardware and the computing time is less than one second or few seconds on a common personal computer. The software is optimized for lobster eye (Angle as well as Schmidt) and various types of multi-foil optics, e.g. hybrid types of Schmidt lobster eye that do not use equal pitch between mirrors. Kirkpatrick-Baey systems can be simulated approximatelly (parabola is approximated by set of line segments), however the approximation can be done with arbitrary precission. Named systems are commonly used for X-rays. As the optimization supposes a specific optics design, the software cannot be used for a generic optics. Lopsimul draws focal image and $\times$ and y profiles. LOPSIMUL calculates FWHM, effective collecting area and other principal results. Lopsimul usage is free of charge.

Tests of Schmidt lobster eye based on new technology

Vladimír Tichý
Vladimír Tichý, Czech Republic

Results of tests of prototype of Schmidt lobster eye based on new technology are presented. Used new techonological concept promises precise assembly of optical mirrors, which is the key aspect to obtain sharp focal image. This concept is subject of patent application and utility model. Outer dimensions as well as focal length were chosen to allow this prototype be boarded on nano-satellite of CubeSat type. The prototype is designed for soft X-ray energies around 1keV. The protoype is intended for imaging for infinity, however, for these preliminary tests, X-ray source placed in a finite distance was used. Images were taken in various angle positions. For each of angle positions, gain and FWHM were measured. Results were compared to results of ray-tracing simulation.

Develpment of the Focusing Mirror in IHEP

Yanji Yang
Institute of High Energy Physics, Chinese Academy of Sciences, China

The enhanced X-ray Timing and Polarimetry mission (eXTP) is a science mission designed to study the state of matter under extreme conditions of density, gravity and magnetism. There are four payloads equipd, SFA, PFA, LAD and WFM. SFA and PFA is charged by IHEP, CAS, the other two payloads are charged by European teams. The Wolter I type focusing mirrors are adopted by SFA and PFA. In the phase B study, the demonstrators are developed by both IHEP and Media Lario S.r.l. The angular resolution is 40 and 24 arcsecs tested by X-ray. Meanwhile, the backup mirror module for Einstein Probe mission is also developed by IHEP, and the angular resolution is 47 arcsecs by 473 nm parrallel visible light.

Investigations of the eROSITA "light leak"

Peter Friedrich
Max-Planck-Institut für extraterrestrische Physik, Germany

MIS

Peter Friedrich, Veronika Stieglitz, Konrad Dennerl, Michael Freyberg:

During the commissioning phase of eROSITA, it was noticed that telescope modules (TM) 5 and 7 were contaminated by optical light: a small fraction of sunlight reaches the CCD, by-passing even the filter wheel. The performance of the other 5 TMs is not affected since their cameras are equipped with aluminium on-chip filters against optical light. With laboratory experiments at MPE, the origin of the light leak in the TM5 and TM7 cameras has been investigated and identified on camera assembly level: the camera head, which has a housing of about 3 cm thick copper to protect against particle radiation, was subject to light transmission studies in which the feedthroughs for heatpipe, flexlead and purging tube were illuminated with high-intensity light sources. It turned out that the heatpipe feedthroughs provide channels through which light can pass towards the CCD while being damped by a factor 10^9 to 10^{10}; it creates a spatial pattern that is very similar to that observed in space. A follow-up experiment with the eROSITA flight-spare camera in a vacuum chamber demonstrated that the light leak appears also under realistic operational conditions. However, the flight spare camera is equipped with an on-chip filter, which weakens the signal and results in a different spatial distribution. It is well known, that the intensity of the optical contamination depends on the orientation of the telescope with respect to the Sun, but it is still unknown, how (Sun) light can penetrate eROSITA's camera platform. By design, it is completely covered by MLI, which is light-tight. It is therefore plausible that part of the MLI was damaged or detached during the launch.

Line Emission Mapper - an X-ray Astrophysics Probe to reveal the hidden drivers of galaxy growth

MIS

Maxim Markevitch
NASA GSFC, United States

The Line Emission Mapper (LEM) is an X-ray mission concept submitted for the NASA Astrophysics Probes call. It combines a large-area, lightweight X-ray mirror with a wide-format microcalorimeter array, covering 30' field of view with 15" pixels with spectral resolution of 1 eV (inner 5'x5') or 2 eV (rest of the array), sensitive in the 0.2-2 keV band. LEM provides a 15x greater grasp (area $\times$ FOV) than Athena XIFU and will excel at studies of faint, diffuse soft X-ray objects, such as the Milky Way, the circumgalactic, intergalactic and interstellar medium. LEM will combine deep pointed observations with a first eV-resolution all-sky survey, which will take 10% of the mission time. LEM's main science theme is unveiling the physics driving galaxy growth by measuring the properties of the diffuse gas within, surrounding, and between galaxies. LEM will be able to observe Earth and Moon. 70% of the non-survey mission time is given to general observers, opening enormous discovery space in many areas of astrophysics, heliophysics and planetary science.

Rocket Experiment Demonstration of a Soft X-ray Polarimeter (REDSoX)

MIS

Herman Marshall
MIT Kavli Institute, United States

We will report on the status of the Rocket Experiment Demonstration of a Soft X-ray Polarimeter (REDSoX), a recently approved NASA mission. The goal of the project is to make the first measurement of the linear X-ray polarization in the 0.2-0.4 keV band. The first flight of REDSoX would target Mk 421, which is commonly modeled as a highly relativistic jet aimed nearly along the line of sight. The instrument is designed to detect polarization as low as 16%. A neutron star with a strong magnetic field would be the target for a future flight. We employ multilayer-coated mirrors as Bragg reflectors at the Brewster angle. By matching to the dispersion of a spectrometer, one may take advantage of high multilayer reflectivities and achieve polarization modulation factors over 90%. Using replicated mirrors from MSFC and gratings made at MIT, we will construct a spectrometer that disperses to three laterally graded multilayer mirrors (LGMLs). The lateral grading changes the wavelength of the Bragg peak for 45 degree reflections linearly across the mirror, matching the dispersion of the spectrometer. By dividing the entrance aperture into six equal sectors, pairs of blazed gratings from opposite sectors are oriented to disperse to the same LGML. The position angles for the LGMLs are 120 degrees to each other, giving the three Stokes parameters needed to determine the source polarization. Our technological approach has significant promise for future missions that would operate in the soft X-ray band, with the potential to extend the bandpass to 1 keV. This program would provide a basis for an orbital mission.

GRINTA, an explorer of the transient sky

Lorenzo Natalucci
Lorenzo Natalucci, Italy

GRINTA (Gamma-Ray International Transient Array Observatory) is a small mission concept developed for future use as highly sensitive hard X-ray (5-400 keV) imager, with a field-of-view of 400 deg2, coupled with a wide field monitor having a sky coverage of ∼2pi. The mission, designed to be placed in Low Earth Orbit (LEO), has the prime objective to study the transient sky via fast repointing to a target. It will study highly variable emission such as gamma-ray bursts and other prompt electromagnetic signatures, as those in conjunction to gravitational waves, tidal disruption and high energy neutrino events. At the same time, it will allow a large amount of planned and serendipitous science, through new sensitive hard X-ray surveys discovering new sources, and driving the identification of hundreds of unidentified soft gamma-ray sources, that are one main heritage of the Swift and INTEGRAL missions. GRINTA will have the capability of fast follow-up observations to allow studying in detail the physical processes in place just after an explosive event, in synergy with all available facilities across the electromagnetic spectrum that will be operational in the next decade.

Status of the AHEAD2020 Program

Lorenzo Natalucci
Lorenzo Natalucci, Italy

The overall objective of AHEAD2020 is to integrate the activities in the field of high energy astrophysics in space, extending to the multi-messenger community, and to promote the domain at the EU level. AHEAD2020 involves 38 participants from 16 countries, including major European institutions in the field, one large space company and 3 SMEs and it offers to users: 30 facilities for instrument tests and calibration of space-based sensors and electronics, data analysis and computational astrophysics/multimessenger modelling, including one virtual access for GW and multimessenger data. The technological development focuses on the improvement of selected technologies for detector instrumentation and X-ray mirrors, for the benefit of currently developed high energy facilities like Athena, wide-field detectors and nanosat constellations. Full exploitation of the new observing capabilities is achieved by the ongoing delivery of tools for data analysis, models and atomic database. Through AHEAD2020, studies of future space-based high energy missions and multi-messenger facilities, such as the next generation of GW interferometers (Einstein Telescope) are being carried out. Finally, AHEAD2020 supports the community via grants for collaborative studies, dissemination of results, and promotion of workshops. Finally, a strong public outreach package ensures that the domain is well publicised at national, European and International level.

MIS

Flying Swift for 20 Years

John Nousek
Penn State University, United States

In 2024 the Neil Gehrels Swift Gamma-Ray Burst Observatory will reach 20 years in orbit. During this time Swift has discovered and localized more than 1500 gamma-ray bursts, conducted the most sensitive all-sky survey in the 100 keV energy band, and set new standards for speed of response, number of individual pointings on the sky, and number of Targets of Opportunity requests served.

As Swift matures we have dealt with several issues of aging, and are seeing the cumulative effect of atmospheric drag which has reduced the satellite's altitude, and which will eventually result in Swift's re-entry to the Earth. I discuss the impact the eventual loss of Swift will cause to current astrophysical programs, and the effect on the category of future missions described as Time Domain and Multi-Messenger Astrophysics (TDAMM) in the most recent NASA Senior Review.

MIS

X-ray observing the cosmic sources by the ESA–CAS satellite SMILE

Vojtech Simon
Astronomical Institute, the Czech Academy of Sciences, Czech Republic

We show the scientific potential of a Soft X-ray Imager (SXI) onboard the ESA-CAS satellite SMILE for investigating cosmic X-ray sources of various types. We show that this instrument, albeit designed for X-ray imaging of the interaction of solar wind with the magnetosheath of the Earth, is also essential for astrophysics because it is able to provide wide-field imaging of the sky in the soft X-ray region. Regarding sufficiently luminous X-ray sources with continuous spectra to be observable by the X-ray monitor MAXI/ISS to assess the object types and their light curves that are expected to be detected by SXI/SMILE, the compact sources accreting matter are promising targets for evaluating the possibilities of SXI. We assumed only the cosmic objects located in the planned fields to be observed by SXI.

The XGIS instrument in the context of the THESEUS ESA M7 mission candidate

MIS

Enrico Virgilli
INAF OAS Bologna, Italy

We describe the design and the performance of the X/Gamma-ray Imaging Spectrometer (XGIS) which is a GRBs and transients monitor developed and optimized for the THESEUS mission candidate for ESA M7. XGIS provides an unprecedented wide energy band (2 keV – 10 MeV), with imaging capabilities and location accuracy < 15 arcmin up to 150 keV over a Field of View of 2sr, a few hundreds eV energy resolution in the X-ray band (<30 keV) and timing resolution down to a few μs. XGIS exploits both an innovative detection system based on silicon drift detectors + CsI scintillator bars and a sophisticated distributed readout electronics (ORION ASIC). In this talk, we will also describe the technological activities we intend to implement both to increase its technological readiness and to further improve the performance of the instrument in terms of effective area and read-out noise.

QUVIK - Quick Ultra-Violet Kilonova surveyor

MIS

Norbert Werner
Masaryk University, Czech Republic

We present the plans for a UV space telescope with two simultaneous UV bands on a 130 kg small-satellite with a moderately fast repointing capability and a near real-time alert communication system that has been selected as a Czech national science and technology mission to be launched towards the end of this decade. The mission shall measure the brightness evolution of kilonovae, resulting from mergers of neutron stars in the UV band and thus distinguish between different explosion scenarios. The mission will also provide important follow-up capabilities in complementary bands for transients discovered by surveys, such as ULTRASAT and Vera Rubin LSST. Between the observations of transient sources, the satellite will perform observations of other targets of interest, a large part of which will be chosen in open competition.

Optimizing the Timepix2 Hybrid Pixel Detector: An In-Depth Exploration of Detector Performance for Scientific and Industrial Applications

David Hladik
Advacam s.r.o, Czech Republic

The introduction of the new hybrid pixel detector Timepix2, as a successor to the well-known Timepix detector, has presented new opportunities for optimizing and characterizing this novel device. In this paper, we study the Timepix2 detector optimization and uncover its behavior, which enables better parameter setting for specific applications, resulting in enhanced device performance. Furthermore, novel signal equalization process was developed and tested. Coupled with optimization efforts, this process yielded significant enhancements in the detector's precision and resolution. Importantly, it also improves the device's ability to capture particles and recognize clusters, thereby significantly elevating its efficacy for applications in high-energy physics. Overall, our study provides valuable insights into the optimization and characterization of Timepix2, highlighting its potential as a powerful tool in various scientific, industrial and space applications.

Performance of detectors on GRBAlpha and VZLUSAT-2 nanosatellite missions

Filip Münz
Masaryk University, Czech Republic

We have developed and demonstrated on orbit a hard X-ray detector based on an increasingly popular combination of a CsI(Tl) scintillator and a set of SiPM detectors, together with in-house built electronic boards for signal shaping and digitization. One such detector is measuring since March 2021 on 1U cubesat GRBAlpha, a pair of identical detectors was installed as a secondary payload on VZLUSAT-2 3U cubesat, launched January 2022. We present evolution of detector performance and degradation on polar Sun-synchronous LEO and their overall capabilities of detecting various astrophysical events, esp. GRBs and solar flares. Namely, GRBAlpha has contributed to a big picture of GRB 221009A, the brightest burst ever recorded in 55 years of study of these phenomena - while it has saturated most of the larger HE observatories, we were able to reconstruct the peak part of the lightcurve with only a moderate pile-up.

The present missions are intended as pathfinders for a larger constellation of nanosatellites that would allow to localize HE events using time-difference triangulation with all-sky coverage. GRBBeta, a follow-up satellite with higher downlink capabilities (to allow millisecond sampling required for localization), is intended to fly next year while similar projects such as HERMES-SP are going to be launched in a near future.

Advancement and future perspectives of BEaTriX

Daniele Spiga
INAF - Brera Astronomical Observatory, Italy

BEaTriX, the beam expander X-ray facility, is operated at INAF-Brera Astronomical Observatory. BEaTriX has been developed and built with the support of ESA, ASI, INAF, the AHEAD program, and will be used to perform the functional test of the 472 mirror modules of NewATHENA based on Silicon Pore Optics (SPO). A great feature of BEaTriX is that it generates a collimated, uniform, monochromatic, and broad (6 cm $\times$ 17 cm) X-ray beam for efficiently testing modular X-ray optics for astronomical telescopes. In addition to the current configuration at 4.51 keV, BEaTriX will soon implement a second beamline at 1.49 keV and a second version of BEaTriX is possibly envisaged at the cosine premises, where the SPO mirror modules are built. BEaTriX2 should consist of two beamlines, one at 1.49 keV and the other at 6.40 keV, and the feasibility study is underway. As of today, BEaTriX is open to users for transnational access through the support of the AHEAD consortium. In this talk we discuss the status of BEaTriX and the future perspective of developments.

Timepix3: Temperature Effects on Radiation Energy Measurements

DET

Martin Urban
Czech Technical University in Prague, Czech Republic

Although the Timepix series of radiation pixel detectors have been successfully used for several years, including several space applications, their characterisation is still not well described, and the influence of environmental conditions on their measurement results is not well documented. One of the most significant environmental effects on the detector in space applications is temperature change. The characterisation of the detector and its temperature dependence is crucial to reduce measurement distortion. This contribution focuses on describing the influence of the detector temperature on the radiation energy measurement and presents the proposed energy spectrum compensation methods.

Multiwavelength and X-ray polarimetric observations of the high-mass X-ray binary Cygnus X-1 during May 2023

AST

Maïmouna Brigitte
Astronomical Institute of the Czech Academy of Sciences, Czech Republic

X-ray binaries are unique systems to study high-energy physics under extreme gravity. Discovered in 1964, the high-mass X-ray binary Cygnus X-1 remains poorly understood. Multiwavelength monitoring, from radio to X-rays, indicates the presence of a 21.2 M⊙, high-spin black hole accreting a 40.6 M⊙ (B0 or O9.7 Iab-type) companion star that emits strong winds in optical. In May 2022, the Imaging X-ray Polarimetry Explorer (IXPE) observed the source in the low/hard spectral state - dominated by the inner corona emission - simultaneously with X-ray and optical telescopes. A year later, in May 2023, Cygnus X-1 transitioned from the low/hard to the high/soft spectral state, where the X-ray flux significantly increases, and the accretion disk's emission dominates. Polarimetric, X-rays and optical monitoring of the source during these two different periods are crucial to understand the geometry and accretion processes in play. I will present the new IXPE results from 2023 and the simultaneous optical observations from the Perek telescope in Ondřejov, in the Czech Republic.

SRG/eROSITA and the first ever clear view of the soft diffuse X-ray sky

AST

Konrad Dennerl
Max-Planck-Institut für extraterrestrische Physik, Germany

The ROSAT discovery of X–ray emission from comets has revealed the importance of a process for the generation of soft X–rays that had been underestimated in its efficiency before: charge exchange. As this process is characterized by high cross sections, even very tenuous gas can become a source of soft diffuse X–ray emission. Such gas is not only present in the Earth's exosphere but also in the whole solar system because interstellar gas is streaming through it. Thus, emission originating in the solar system may be present in any X–ray observation, affecting all studies of the local hot bubble, the galactic corona, the circum-galactic medium, and the cosmic X–ray background. With its privileged location outside the Earth's exosphere, SRG/eROSITA is the first satellite to see an X–ray sky that is free from geocoronal emission, and by scanning over the full sky repeatedly, it provides a unique opportunity to identify and isolate the time variable heliospheric component. I will show how we utilize this unprecedented situation to obtain, for the first time ever, a clear view of the soft diffuse X-ray sky and to study the X-ray emission of our heliosphere.

X Rays burst and flare in space from the Earth Horizons

Daniele Fargion
Sapienza University of Rome, Italy

Downward Airshowers by TeVs- EeVs cosmic rays, CR, on Earth arrays, as Hawc and LHAASO, are mostly traced by their vertical abundant electron and muon secondary pairs.

Among the airshowers secondaries, the additional abundant parasite X-rays are soon absorbed by the same deep terrestrial atmosphere.

At high altitudes (30-50 km) or in Space the skimming Tevs-EeVs CR at horizons may airshower and shine in very diluted air, also with their unabsorbed and abundant X-rays, as well as also with electron or rare muon pairs.

These skimming CR showers in high atmosphere fly hundreds or thousand kilometers toward baloons or satellites. Their additional Cherenkov flashes are expected to reveal, at micro-milliseconds, Ultra High Energy Cosmic Rays, UHECR, in future POEMMA or Jem-Euso satellites.

The MeVs-Gevs electron pairs secondaries are bent and curved by geomagnetic fields, ejecting in X-rays for longer time than any ideal beamed straight charge. Therefore their UHECR duration in X-rays may shine along wide, few degees, angle, surviving millisecond times.

However, also, the hardest TeVs-GeVs gamma flares, as recent GRB221009A, surviving hundreds of seconds, might be skimming and showering in highest atmosphere horizons into more persistent $\times$ flares.

Indeed the presence of such X-long-rays flares, with or without their electron pairs signals, at horizons could be overlapping the hardest gamma burst or flares, is here foreseen.

We show in details why, how and when such X-ray flares are observable, or better, when they could have been already observed.

The Impact of Space Experiments on the Knowledge of Our Universe

Franco Giovannelli
INAF - Istituto di Astrofisica e Planetologia Spaziali (IAPS), Italy

Space experiments have opened practically all the electromagnetic windows on the Universe.

With the advent of space experiments it was demonstrated that cosmic sources emit energy practically across all the electromagnetic spectrum via different physical processes. Several physical quantities give witness to these processes which usually are not stationary; those physical observable quantities are then generally variable. Therefore "simultaneous multifrequency observations" are strictly necessary in order to understand the actual behaviour of cosmic sources. A discussion of the most important results coming from "multifrequency photonic astrophysics" experiments will provide new inputs for the advance of the knowledge of the physics, very often in its more extreme conditions.

In this paper I will try to describe the last steps of the investigation born with the advent of space experiments, to note upon the most important results and open problems still existing, and to comment upon the perspectives we can reasonably expect.

The History of High Energy Experiments: from UHURU to IXPE

Franco Giovannelli
INAF - Istituto di Astrofisica e Planetologia Spaziali (IAPS), Italy

In this talk I will present an exursion on the history of the High Energy (HE) space experiments designed for Ultraviolet (UV), Soft and hard X-rays, and Gamma-rays energy ranges, starting from the first satellite UHURU until IXPE (Imaging X-ray Polarimetry Explorer). The main results obtained will be discussed. Thus it will be possible to follow the advancement of our knowlege of the HE-Universe along roughly 50 years with several examples that in my opinion provided the solution of important steps for understanding the physics governing our Universe.

Of course, this discussion do not pretend to be complete because of my limited knowledge and the lenght of this paper.

Search for common features in GRB optical and X-ray lightcurves

Martin Jelínek
ASÚ AVČR, Czech Republic

Early GRB lightcurves, both in X-ray and optical domains, are a very interesting source of information of these events. The early X-ray lightcurves are typically dominated by the inner engine contribution and only later the external-shock (afterglow) contribution becomes dominant. At optical wavelength, the onset of the afterglow can be seen as well as a contribution of a faster-decaying early flare, commonly attributed to a reverse shock in the same region as the afterglow. Apart of the external shock, in the optical domain we sometines may observe a subtle reflection of the X-ray activity. I will present an overview of the current understanding of what is or may be happening during the earliest minutes of a GRB emission.

On particle acceleration near a magnetized rotating black hole

Vladimir Karas
Astronomical Institute of the Czech Academy of Sciences, Czech Republic

Magnetized black holes are considered promising as potential sources of highly energetic particles. A combination of relativistic frame dragging and magnetic field reconnection can accelerate electrically charged particles to the values of Lorentz factor order of several tens to hundreds. We explore the emergence of magnetic null points and the resulting acceleration of charged particles near the ergosphere. While the magnetic reconnection occurs in the presence of plasma and may lead to violent mass ejection, we show here that strong gravitation of the supermassive black hole can actively support this process by entangling the field lines even within the electro-vacuum limit.

The X-ray Bubbles at the Galactic Center

Peter Predehl
Max-Planck-Institut für extraterrestrische Physik, Germany

The North Polar Spur is the largest and most conspicuous emission structure in both the radio and X-ray domain. Since its discovery about 60 years ago, its origin has been debated: is it either an ancient remnant of a nearby supernova explosion, or part of a 'hypershell' originating from the Galactic central region. The debate gained new momentum after the discovery of the so-called Fermi Bubbles at gamma energies more than 10 years ago. However the main argument against the hypershell theory was the lack of a southern counterpart symmetric to the northern structure. The main task of the X-ray telescope eROSITA on the Russian/German SRG mission is to systematically survey the sky eight times. Already in the first survey the existence of the southern counterpart could be proven. Henceforth, this structure was named eRSOSITA Bubbles in reference to the Fermi Bubbles. Since then, several questions are being debated: What is the origin of the eROSITA Bubbles, an AGN activity about 15 million years ago, or a quasi-continuous starburst activity? What is the connection to the galactic halo? Do we observe a similar scenario in other nearby spiral galaxies?

Synoptic Astrometry of the lensed Quasar HE0435-1223: X-ray Varstrometry

AST

Dan Schwartz
Smithsonian Astrophysical Observatory, United States

X-ray telescope missions planned within the next 50 years will not have angular resolution substantially better than 0.5 arcsecond. At redshifts z > 1 such angular resolution corresponds to linear scales of 2-4 kpc, which is not sufficient to address questions of how dual supermassive black holes evolve, and how they affect their galaxies via jets and winds, as these phenomena happen on scales below hundreds of pc. To overcome these limits, we are innovatively using gravitational lenses as telescopes to compare X-ray, optical and radio emissions in quasars on milli-arcsec scales. We analyzed 11 Chandra observations over a 14 year time span of the lensed quasar HE0435-1223 at redshift z=1.689. Assuming we are observing the same X-ray source, we combine this data to locate the source to an accuracy of 0.5 milli-arcsec, to 67% confidence, finding a positional offset with respect to the optical quasar to an equivalent 3.36 sigma deviation. Such an offset most likely would be due to a pc-scale X-ray jet, or a dual AGN. Another approach to search for duality is to invoke Varstrometry, here applied in the X-ray band for the first time. A pair of unresolved, variable sources will reveal position jitter over time as the centroid of the emission is biased by whichever of the two is brightest during the observation. From an upper limit to the position jitter, and a measurement of the flux variations, we establish a 1-sigma upper limit of 47 mas, 410 pc, to the separation of two putative quasars of equal mean flux.

X-ray polarimetry view of stellar-mass accretion black holes

AST

Jiri Svoboda
Astronomical Institute of the Czech Academy of Sciences, Czech Republic

Stellar-mass accreting black hole are ideal laboratories to study accretion physics under conditions of extremely strong gravity. While the spectroscopic and timing studies proved that the X-ray emission is coming from a few gravitational radii around black holes, the X-ray polarimetry is particularly suitable tool to investigate the exact geometry of accreting material and so-called corona, scattering the X-ray emission. The Imaging X-ray Polarimetry Explorer, launched two years ago, opened a new window to sensitively measure the polarimetric properties of X-rays from stelar-mass black holes. In this talk, I will discuss main results obtained from the spectro-polarimetric measurements of several bright black-hole X-ray binaries observed by this space mission.

Modulation mechanism of twin-peak quasi-periodic oscillations in neutron star X-ray binaries

AST

Gabriel Török
Silesian University in Opava, Czech Republic

The twin-peak quasi-periodic oscillations (QPOs) observed in neutron star (NS) X-ray binaries, represent a possible tool for probing strong gravity and dense matter equation of state. Nevertheless, the QPO modulation mechanism remains an unresolved puzzle, especially because the QPO amplitudes are sometimes as high as 30% rms. Oscillations of an inner accretion torus can modulate the accretion rate and induce a NS boundary layer (BL) variable luminosity. Using relativistic ray tracing, we investigate light curves originating from variable BL and oscillating toroidal structures of accreted fluid. We identify the scenario which allows for high QPO amplitudes and discuss implications for a variety of QPO models. In the case of simulation including torus exhibiting radial and vertical oscillations, we observe frequency peak corresponding to the vertical oscillations, which has not been identified in previous hydrodynamical simulations of accretion. We also show that when oscillations disrupt the torus stability, the resulting product strongly imprints the Keplerian frequency in the observed light curve.

Multi-phase gas, accretion and jet power in early-type galaxies

AST

Norbert Werner
Masaryk University, Czech Republic

Most galaxies comparable to or larger than the mass of the Milky Way host hot, X-ray emitting atmospheres and central radio sources. Hot atmospheres and radio jets and lobes are the ingredients of radio-mechanical active galactic nucleus (AGN) feedback. At least half of the most massive early-type galaxies harbour multi-phase filamentary gas, which appears to result from the thermally unstable cooling of their hot atmospheres. We will present recent results based on X-ray and radio observations, which indicate that in massive early-type galaxies, the central radio sources are mostly switched on. We will show that for galaxies with thermally unstable hot atmospheres, the mechanical jet power correlates strongly with the Bondi accretion power. Further investigating the dependence of jet power on individual quantities in the Bondi formula, such as the supermassive black hole mass and the specific entropy of the gas at the Bondi radius, we find a very tight correlation between the jet power and black holes mass and, although poorly constrained, a hint of an anti-correlation between jet power and entropy. The results indicate that at least for thermally unstable systems, the jet power is set primarily by the supermassive black hole mass. It appears that once the atmosphere becomes thermally unstable, the cooling gas feeds the black holes in the centres of all galaxies at a similar jet-to-Bondi power ratio, possibly indicating a key universal property of black hole accretion in early-type galaxies. Importantly, since the central black hole mass of X-ray luminous early-type galaxies correlates with the total mass of the host halo, more massive systems undergoing thermally unstable cooling will naturally have larger jet powers.

Nuclear X-ray outbursts every 22 days

Michal Zajaček
Masaryk University, Czech Republic

We report the detection of unique quasiperiodic soft X-ray outbursts from the nucleus of the galaxy Swift J0230+28. The ourbursts repeat quasiperiodically every 22 days, although with a large scatter in recurrence. The galaxy has been low-luminous before the start of outbursts and in between the flares, the quiescent level has not been detected. X-ray eruptions were detected by the Swift X-ray telescope and the subsequent high-cadence monitoring was performed by NICER. We discuss several plausible mechanisms behind the eruptions, with the Roche-lobe overflow from a single evolved star being a likely interpretation. In addition, the eruptions could have been triggered by two orbiting coplanar stars or condensation cores with the TDE stream.

AXRO introduction and historical background

Rene Hudec
ASU AV CR & CTU, Czech Republic

The AXRO history is related to the history of X–ray astronomy in general and to the history of X-ray optics developments in the Czech Republic (and formerly in Czechoslovakia) in particular. The first Czech X-ray mirror was built already in the years 1969/1970, for a solar telescope within the Eastern Europe/Soviet INTERKOSMOS program, There were also essential efforts devoted to the development of novel technologies for satellite projects which were either canceled or interrupted. The two wasted years of development on the technology of high-quality Ni foils for the Danish SODART telescope (Schnopper, 1990), 1986-1988, can serve as an example. The SOviet-DAnish Roentgen Telescope (SODART) was planned for on board the Spectrum Roentgen Gamma (SRG) satellite equipped with three different instruments devoted to X–ray spectroscopy. Each of the two thin foil telescopes had an 8m focal length, a 60 cm diameter, a 1 deg field-of-view (FOV), a half-power width better than 2 arcmin and ca. 1 700 and 1 200 cm^2 collectingarea at 2 and 8 keV, respectively. In the last three decades developments of innovative technologies for X-ray optics continued with an emphasis on glass foils and silicon wafers mostly in Multi Foil Optics arrangements and Schmidt Lobster Eye and Kirkpatrick Baez geometries.

Concluding Remarks

Franco Giovannelli
INAF - Istituto di Astrofisica e Planetologia Spaziali (IAPS), Italy

Concluding Address

Rene Hudec
ASU AV CR & CTU, Czech Republic

List of Participants

Wayne Baumgartner	United States
Alex Bayerle	Netherlands
Maïmouna Brigitte	Czech Republic
Vadim Burwitz	Germany
Konrad Dennerl	Germany
Vladimír Dániel	Czech Republic
Daniele Fargion	Italy
Peter Friedrich	Germany
Franco Giovannelli	Italy
Fabien Grisé	United States
Danielle Gurgew	United States
Alexandra Higley	United States
David Hladik	Czech Republic
Rene Hudec	Czech Republic
Adolf Inneman	Czech Republic
Martin Jelínek	Czech Republic
Zuzana Kapounová	Czech Republic
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Maxim Markevitch	United States
Herman Marshall	United States
Veronika Maršíková	Czech Republic
Jake McCoy	United States
Randall McEntaffer	United States
Lenka Mikuličková	Czech Republic
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Dan Schwartz	United States
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Vojtech Simon	Czech Republic
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Jiri Svoboda	Czech Republic
Vladimír Tichý	Czech Republic
Gabriel Török	Czech Republic
Martin Urban	Czech Republic
Enrico Virgilli	Italy
Norbert Werner	Czech Republic
Yanji Yang	China
Michal Zajaček	Czech Republic
Vratislav Šálený	Czech Republic
Zdislav Šíma	Czech Republic

Useful Information

Emergencies

There are several important numbers:

112 The Single European Emergency Call Number
158 Police of the Czech Republic
155 Emergency medical services
150 Fire and rescue service of the Czech Republic

In case you are in an emergency situation or witness such a situation and do not know where exactly you are, report your **location** using the **six-digit number** on the nearest street **lighting pole** to the emergency services.

Internet connection

Wi-Fi will be available during the conference.

SSID:
PASS:

There is also access to the **Eduroam network** in the conference venue.

Public transport

The nearest public transport stop to the villa Lanna is Hradčanská (green Metro Line A, Tram: 1, 2, 8, 18, 20, 25, 26, and Bus 131).

Bus/metro/tram rides do not need to be booked in advance. The passengers must buy a ticket before on-boarding and validate it immediately after boarding the bus/tram or before the entrance to the metro station by a small yellow stamping machine. Validity is limited only by time, number of transfers is not limited.

Tickets can also be purchased via SMS (only czech mobile numbers) or the **Lítačka mobile app**, which can also be used to search for the ideal public transport connection. The application is available for Android or iOS.

More information about transportation, prices and connections can be found at `http://www.dpp.cz/en/`

Time	Price
30 minutes	30 CZK
90 minutes	40 CZK
24 hours	120 CZK
72 hours	330 CZK

Social event

Thursday, 7 December	
15:00	**Meeting place:** Entrance hall of Vila Lanna
16:00 - 17:30	Clementinum guided tour (Dr. Zdislav SIMA, CSc)
18:00 - 22:00	Conference dinner
	(Baroque refectory of the Dominican monastery)

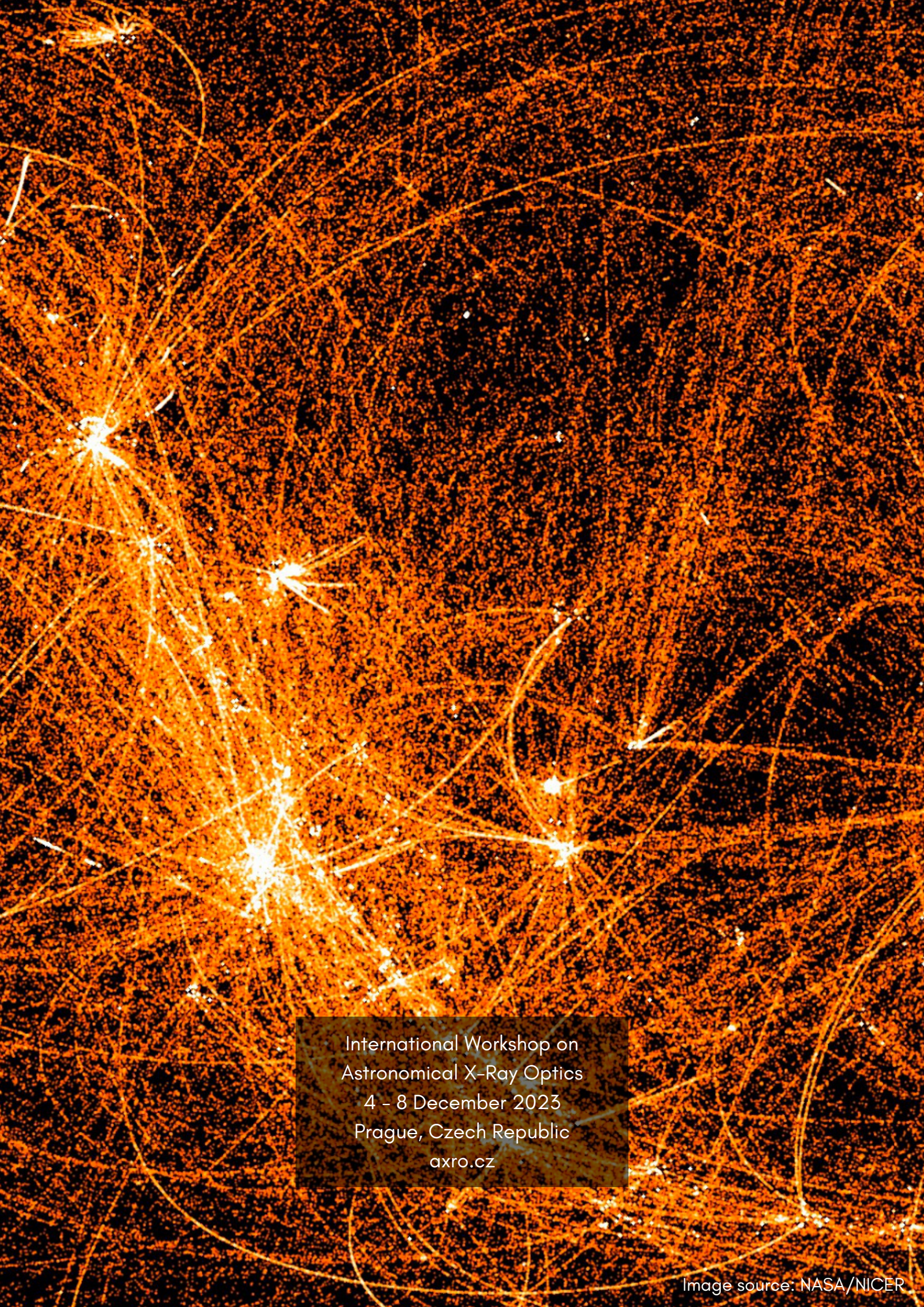
A unique sightseeing route through a part of the Clementinum, the former Jesuit college, takes you to the Astronomical Tower and the extension that connects it to the northern wing of the Clementinum complex. Here you will have a guided tour of the Baroque Library, described as the most beautiful library in the world. The next stop on the tour is the Meridian Hall with period astronomical instruments on the 2nd floor of the Astronomical Tower. For three hundred years the giant Atlas carrying a sky full of stars on his shoulders has been looking down from the top of the tower.

The Clementinum Astronomical Tower
One of the landmarks of the former Jesuit college is the Astronomical Tower, situated in the centre of the Clementinum courtyards. The height of the tower from the base to the top is 68 metres, the circular viewing balcony at 52 metres can be reached by climbing 172 steps. The top of the tower, visible from afar, is adorned with a lead statue of Atlas carrying a celestial sphere on his shoulders. Around 1750, an important phase of astronomical and climatic measurements and observations began here.

The Baroque Library
Prague boasts one of the most beautiful Baroque libraries in the world. The library hall with its large, historically valuable globes and beautiful fresco decorations by John Hiebel on the themes of science and art was completed in 1727. The library collection, which is still open, contains over 27,000 volumes of mostly foreign-language theological literature.

The Meridian Hall
This mysterious room is located on the 2nd floor of the Clementinum's Astronomical Tower; it has been hiding a unique slotted sundial behind its door since the 18th century. Through a small hole high in the wall, a ray of sunlight penetrated and turned the small space into a camera obscura. The sunlight fell on a string stretched on the floor and their fusion determined with great precision the moment of noon, the exact time when the sun is at its highest point in its imaginary orbit. Two original astronomical instruments - mural quadrants - have also been preserved in the walls of the hall.

Participants are advised of the difficulty of the tour due to the high number of staircases and that they undertake the tour at their own risk, especially taking into account their current fitness and overall health. The lift is not available. The sightseeing route is not wheelchair accessible.



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