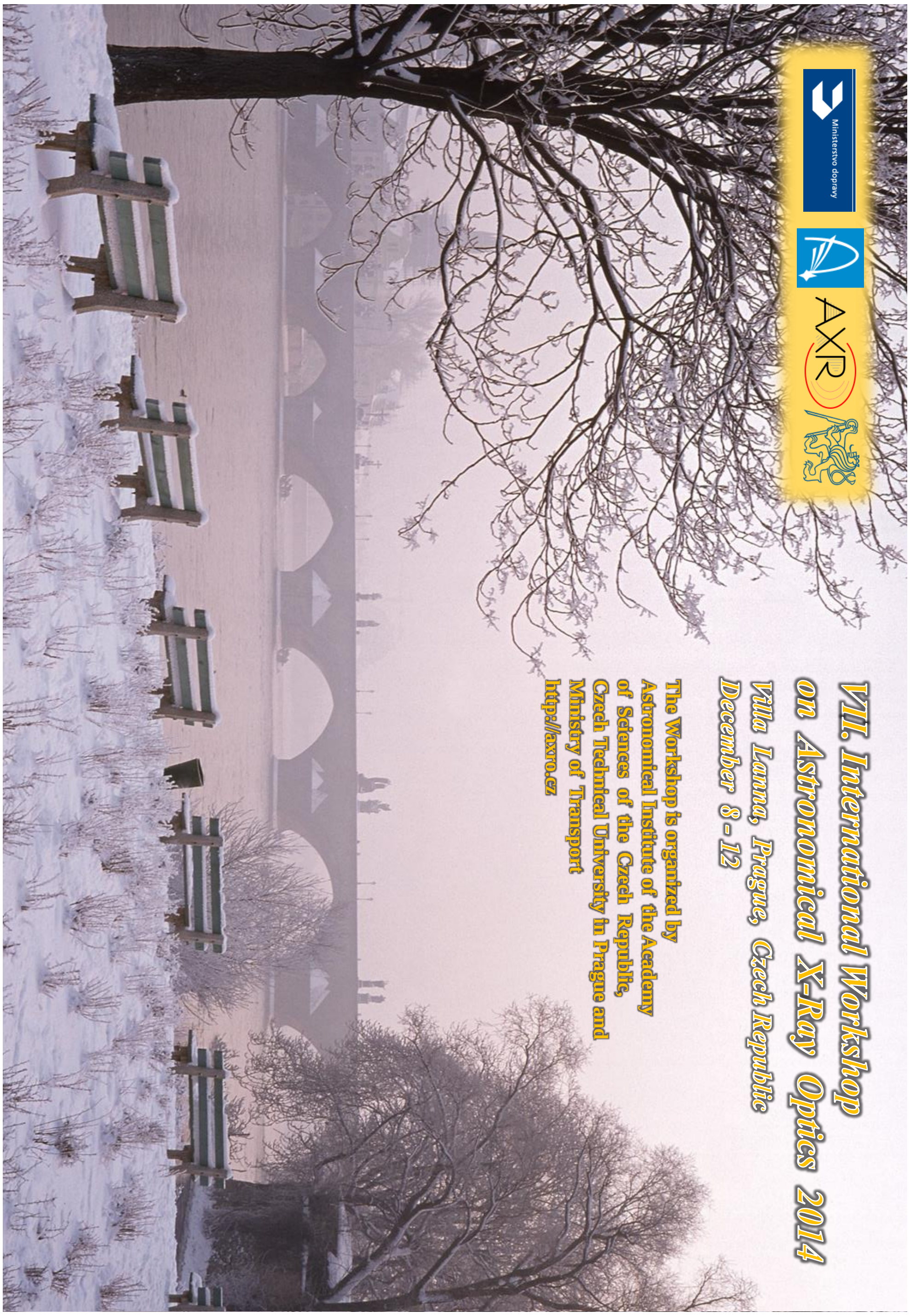
AXRO 2014
BOOK OF ABSTRACTS



AXRO 2014
7th International Workshop on Astronomical X–Ray Optics

http://axro.cz

December 8-11, 2014
Prague, Villa Lanna, V Sadech 1, 160 00 Prague 6
(GPS: 50° 6' 9.022''N, 14° 24' 25.341''E)

Organizers :

Astronomical Institute of the Academy of Sciences
Czech Technical University in Prague
Ministry of Transport, Czech Republic

Local Organising Committee:

Radka Havlikova, KFE FJFI ČVUT [radka.havlikova@fjfi.cvut.cz]
Michaela Skulinova, AI AS CR Ondrejov & CSA
Martin Blazek, CTU Prague
Stanislav Vitek, CTU Prague

Program Committee:

Assoc.Prof. Rene Hudec (chair) [rene.hudec@gmail.com]
Prof. Martin Elvis
Prof. Dick Willingale
Prof. Rob Petre
Prof. William Zhang
Prof. Giovanni Pareschi
Prof. Webster Cash,
Prof. Hideyo Kunieda
Dr. Steve O'Dell
Assoc. Prof. Ladislav Pina
Prof. Randall McEntaffer
Prof. John Nousek
Prof. Kirpal Nandra

Space Activities in the Czech republic

Václav Kobera

- - -

AXRO Introduction and Historical Background

Rene Hudec

The history and background of AXRO workshop will be briefly introduced and discusssed.

X-Ray Telescopes

Aschenbach Bernd

Some physics and some personal reflections

Predictions for the harmonic content of high-frequency quasi-periodic oscillations with LOFT

Vladimir Karas

We discuss the harmonic content of X-ray light curves predicted by two competing scenarios, namely, the orbiting spot model and the oscillating torus model. We estimate the required signal-to-noise ratio of the model light curve and we discuss what improvements can be achieved with the proposed LOFT satellite, depending on the source brightness.

Examples of activity observed by the X-ray monitors

Vojtech Simon

Monitors of X-ray emission are important instruments for observing the activity of binary X-ray sources on long timescales (even of years). Rapid variations of intensity of these sources are smoothed in the often used one-day means of the data provided by these monitors, and these observations provide information about the long-term activity. On the case of Her X-1 observed by the All Sky Monitor (ASM) onboard RXTE, this talk will show a method of addressing the problem of measuring the long-term evolution of the X-ray intensity in the light curve which consists only of separated intense spikes. I will also show investigation of the evolution of the very long outburst and the superimposed fluctuations of the transient XTE J1701-462 monitored by ASM/RXTE and BAT/Swift.

Physics of the Cosmos Program Analysis Group

John Nousek

The Physics of the Cosmos program is NASAś theme which considers the Universe as a grand laboratory of discovery, fulfilling our needs to probe physics at scales unachievable within an Earth-based laboratory, and to answer the fundamental questions of how our Universe came to be. As current Chair of the Physics of the Cosmos Program Analysis Group, I will describe NASA's plans for the near and medium term future. In particular, I will describe the 30 Year Roadmap developed by Chryssa Kouvelioutou and her colleagues, which lays out the path of potential missions and how they form a coherent and effective plan to pursue these ambitious goals.

Strong gravity with Athena

Jiri Svoboda

I will briefly summarise how the X-ray spectroscopy is used for studying strong gravity around super-massive black holes in active galactic nuclei. I will discuss the expected scientific outcome with the next large X-ray mission planned by ESA, Athena.

The X-ray spectral and timing behaviour of the accreting pulsar V0332+53

Maria Caballero-Garcia

The X-ray emission from accreting stellar-mass black holes in LMXBs has been studied for many decades. This is due to the length of their X-ray outbursts, which have allowed intensive observing campaigns using data from satellites such as XMM-Newton, Chandra, SWIFT, RXTE, Suzaku, INTEGRAL, etc. In the case of HMXBs, and in particular for accreting X-ray pulsars, their X-ray emission is far from being understood. This is due to their short episodes of X-ray emission and complex physical properties, including strong magnetic fields. In this talk we present some preliminar results from the spectral and timing analysis of the recent outbursts from the Be X-ray pulsar V0332+53.

X-ray Astrophysics

Martin Topinka

I will present three case examples (neglecting many others) of essential use of X-ray observations in astrophysics: accretion on compact objects, detection of dark matter in galaxy cluster collisions and gamma-ray bursts.

Results of experiments on the effect of x-ray on an amino acid

Hatem Ben Loucaief

- - -

Innovative X-ray Optics for the ESA Space Science Program

Marcos Bavdaz

ESA has selected the X-ray observatory mission Athena as the second large class mission for its science program. This mission was enabled by the development of the silicon pore X-ray optics, which spins-in technologies from the semiconductor industry. Several activities are running and others are planned to mature the technology for the space mission Athena.

Slumped glass optics for future X-ray telescope: achievement and perspectives

Marta Civitani

Future X-ray telescopes with very large collecting area need to be realized as assemblies of a large number of X-ray optical units, named X-ray Optical Units (XOUs). The slumped glass optics (SGO) is a technology to manufacture these modular elements, compatible with an angular resolution of 5 arcsec HEW (Half-Energy-Width). This technique consists in stacking in a Wolter-I configuration several layers of thin foils of glass, previously formed by hot (direct or indirect) slumping. We provide an overview of the project development, reporting on the very promising results achieved so far, on the on-going activities and on the overall optical-mechanical design up-grade to go from the present 20 m to 12m focal length (to be compatible with Athena+ configuration). This is OAB/INAF and MPE joint effort.

Indirect slumping of thin glass sheets for future X-ray telescope mirrors

Anita Winter

The development of light-weight mirror systems is of great importance for future larger X-ray telescopes, which aim for significantly larger effective area within the given mass limit. At MPE we follow the approach of thermally slumped glass sheets and a modular integration scheme. Recently we have combined forces with the colleagues from OAB to produce a joint module using the indirect slumping approach combined with the Italian integration method. The progress of this project will be presented, as well as further developments at MPE in order to optimise the resolution and quality of the mirror shells.

Optimizing thermal forming of glass and Si foils for x-ray telescope mirror

Martin Míka

Glass and Si foils were formed by slumping at elevated temperatures in the region of plastic deformation. The effects of slumping conditions on the shape and surface quality were measured. To produce glass and Si foils of precise shape and low microroughness, the heat-treatment time and temperature of the slumping process were optimized.

X-ray Optics Development at MSFC

Mikhail Gubarev

The X-ray astronomy group at the Marshall Space Flight Center (MSFC) is fabricating x-ray optics for suborbital and orbital experiments. Another component of our work is the development of fabrication techniques and optical metrology to improve the angular resolution of thin-shell optics Details and status for the fabrication of the optics and technology developments will be presented.

Direct Polishing of Full-Shell, High-Resolution X-Ray Optics

Jackie Roche

Marshall Space Flight Center (MSFC) is investigating direct polishing techniques to develop technology readiness for full-shell, high-resolution x-ray optics. To date, theoretical models and initial results indicate a potential success; a 7-axis polishing machine and cylindrical-shaped glass has been purchased; blocking fixtures and grinding tools have been designed and built; and corrective grinding has been demonstrated using a Coordinate Measuring Machine (CMM) for metrology and MATLAB for creating a g-code.

Development of High-Resolution and Lightweight Astronomical X-ray Optics

William Zhang

Future X-ray astronomical missions require optics that must be of both high angular resolution and large effective area. A collaboration of Goddard Space Flight Center and Marshall Space Flight Center is engaged in an effort to advance the technology of making x-ray optics to meet those requirements. This effort is based on precision slumping of commercial glass sheets and precision polishing and light-weighting of single crystal silicon mirrors, the former well-suited for making 10" x-ray telescopes and the latter for much higher angular resolution approaching the diffraction limit. The objective of the development effort is to make ready a ∼1" mirror technology by 2020 and a ∼0.1" mirror technology by 2030, both of which will be done with mass and cost per unit effective comparable to those of Suzaku and NuSTAR, about an order of magnitude less than those of Chandra. In this talk I will describe this effort and report on its development status.

Alternative Technologies for Large X-Ray Telescopes

Rene Hudec

Future large space X-ray telescopes require novel technologies and arrangements. In the talk I will review alternative technologies and approaches which can be useful for future projects.

Challenges Facing Soft X-ray Spectrometers

Randall McEntaffer

Future X-ray missions require diffraction gratings with high throughput and high spectral resolving power to achieve science goals specific to soft X-ray spectroscopy. Recent advances in grating fabrication and system integration have elucidated a path forward for achieving the associated performance requirements using off-plane reflection gratings. I will discuss the current state of developments in this field and also describe the key challenges in realizing a large, space-based soft X-ray spectrometer. Techniques to overcome these challenges will be discussed with an emphasis on near term technology developments that are already occurring.

The narrow field lobster Eye Telescope for SVOM

Richard Willingale

The French-Chinese SVOM mission incorporates a X-ray telescope (MXT) for followup observations of GRBs and similar triggers. The MXT is a narrow field lobster eye design which comprises and array of square pore Micro Channel Plates that offer the optical performance for very low mass. The MXT has an effective area of $\sim$30 cm^2 at 1 keV and an angular resolution of $\sim$4.5 arc minutes. A breadboard model of the optics are currently under build and test at the University of Leicester. I will describe the optical design of the SVOM obster eye MXT and present the preliminary results of the X-ray performance from the breadboard model.

Mathematical descriptions of multi-foil optics

Vladimír Tichý

First, numerical method based on simplifying common ray-tracing procedure is presented. Some optics, like Schmidt lobster eye does not require to calculate traces of all rays are necessary to simulate but only of few ones. Therefore, the presented method is extremely effective. Moreover, to simplify the equations, the specific mathematical formalism is used. Because only few simple equations are used only, the program code can be simple as well. At next, analytical model describing Schmidt lobster eye optical parameters on dependence on its geometric parameters is presented. Negative parameters like mirror reflectivity and mirror thickness are included to the model.

Advances in MEMS X-ray optics

Yuichiro Ezoe

We present recent progress in micropore X-ray optics based on micromachining technologies. New results on a Wolter type-I telescope designed for future Japanese planetary missions will be shown.

Hard X-ray monitoring for astrophysical application

Ladislav Pina

This work addresses the issue of X-ray monitoring for astrophysical applications. The proposed wide-field optical system has not been used in space yet. The proposed novel approach is based on the use of 1D "Lobster eye" optics in combination with Timepix X-ray detector in the energy range 3 - 40 keV. The proposed project includes theoretical study and a functional sample of the Timepix X-ray detector with multifoil wide-field X-ray "Lobster eye" optics. Using optics to focus X-rays on a detector is the only solution in cases the intensity of impinging X-ray radiation is below the sensitivity of the detector, e.g. while monitoring astrophysical objects in space, or phenomena in the Earth's atmosphere. The optical system could be used in a student rocket experiment at University of Colorado. Ideal opportunity is to extend the CubeSat of Pennsylvania State University with the hard X-ray telescope demonstrator consisting of an optical module and Timepix detector.

RXJ0852.2-4622 alias Vela Jr. - the Remnant of the Nearest Historical Supernova: Impacting on the Present Day Climate?

Aschenbach Bernd

RXJ0852.2-4622, a supernova remnant, is demonstrated to be closer than 500 pc. This estimate is derived by a new method involving for the the first time the TeV gamma-ray flux. The remnant is likely to be not older than 700 years, supported by astro-archeology findings, nitrate inclusion in drilled ice-core, and most recently by a substantial increase of radio carbon around the suspected explosion date. The impact of present day climate change is discussed.

Ten years of Swift

John Nousek

On 20 Nov 2014, Swift passed its tenth anniversary of successful operations. I will review the scientific achievements of the Swift mission, and describe our new initiatives to further invigorate this outstanding success story.

New Astronomical Observations at wavelength range 1-4 nm above 46° 24' E, 24° 54' N

Yaser Hafez

This study aims to observe nearby sky objects such as Sun, Moon and major planet at X-ray wavelength range from 1 to 4 nm using a new telescope above Al'Uyayna (46° 24' E, 24° 54' N) for the first time in this area of the world. In the study we focused on observing the new moon when it is very close to the sun, where this is recognised as a serious challenge for most of ground-based telescopes. As the X-radiation is absorbed by atmosphere, we also present a new study of the atmospheric absorption in percentage at different altitudes above our location using special instrument to measures the atmospheric effects at these altitude levels. This will give use better understanding to the behaviour of the atmosphere and its effect on the astronomical observations at 1-4 nm wavelength range, and so we could achieve more accurate measurements at this wavelength range. Finally, a full description of this new telescope technical parameters and its design will be also described. Minutes

Advances in the hot slumping assisted by pressure

Bianca Salmaso

We present the recent progress in the hot slumping assisted by pressure of thin glass foils for X-ray optics. The direct approach, historically adopted at INAF-OAB, was studied both with a center to border approach and with the opposite border to center. The differences in the two approaches are presented, specially from the point of view of air entrapping and mould shape copying. The indirect approach, used by the MPE group and now studied also at INAF-OAB in the frame of a collaboration between the two groups, was approached at INAF-OAB with different glass types and mould materials. The ongoing and future activities are presented.

Developing, Testing and Calibrating the eROSITA and other X-ray Optics at PANTER

Vadim Burwitz

The status of the development, testing, and Calibration of the eROSITA X-ray mirrors at PANTER will presented. Also the development and testing at PANTER of optics for future missions will be discussed.

Optical study of nano-satellite x-ray monitor

Vladimír Tichý

The Schmidt lobster eye design for a grazing incidence X-ray optics provides wide field of view of the order of many degrees, for this reason it can be a convenient approach for the construction of space X-ray monitors. Schmidt lobster eye is possible to assemble in various scales of dimensions and also dimensions and focal lengths acceptable for nano-class satellites are possible. In this paper, draft of nano-class space mission providing monitoring of specific sky area is presented. Preliminary optical design study for such mission is performed. Two of possible opticle designs are presented. For those designs, field of view, effective input area and other basic optical parameters are calculated.

Atmospheric optics

Youness Bentahar

The atmospheric turbulence is the biggest obstacle to terrestrial astronomical observations. It prevents us to obtain precise images of equality precision of the space telescopes. In spite of the attempt to minimize this inconvenience by choosing good site for the creation of new observatories, this is certainly not sufficient, it is indispensable to know with precision the state of the turbulence in order to correct it with adaptive or active optics During these last years, the scientists try to know details and characteristics of the atmosphere. The knowledge of these characteristics such as the parameters: r0, L0, h is of a major interest in astronomical observation for angular high-resolution optimization of techniques (adaptive or active optics). The objective of this study is to estimate these parameters the case of observation of the sun by the statistical analysis of arrival angle fluctuation and this can be directly obtained from the observations of the solar edge.

Shading light on the cosmic dawn with THESEUS

Lorenzo Amati

I will present the Transient High Energy Sky and Early Universe Surveyor (THESEUS), a proposal under preparation for ESA/M4 and next opportunities. The main goal of the proposed mission are: a) exploring the Early Universe (cosmic dawn and eionization era) by unveiling a complete census of the Gamma-Ray Burst (GRBs) population in the first billion years; b) performing an unprecedented deep survey of the soft X-ray transient Universe. This is achieved via a unique payload providing an unprecedented combination of 1) wide and deep sky monitoring in a broad energy band (0.3keV - 20 MeV); 2) focusing capabilities in the soft X-ray band granting large grasp and high angular resolution; 3) on board near-IR capabilities for immediate transient identification and first redshift estimate.By satisfying the requirements coming from the above main science drivers, the THESEUS payload will also automatically be capable to perform excellent secondary and observatory science. The payload consortium is presently led by Italy, UK and France, with significant contributions by Denmark, Poland, Spain, Czeh Repubblic and Slovenia.

The X-γ-ray Spectrometer for THESEUS

Filippo Frontera

I will report on the instrument foreseen for the THESEUS mission proposal that spectroscopically will extend the energy band of the Lobster-eyes telescope. The instrument concept is new, makes use of an array of both a scintillator and a Silicon Drift Detector optically coupled,and has a broad energy passband, from about 2 keV up to 20 MeV.

ART-XC telescope of SRG project, current status

Mikhail Pavlinsky

Spectrum Roentgen Gamma (SRG) is an X-ray astrophysical observatory, developed by Russia in collaboration with Germany. The mission will be launched in 2016 from Baikonur, by a Zenit rocket with a Fregat booster and placed in a 6-month-period halo orbit around L2. The scientific payload consists of two independent telescopes - a soft-x-ray survey instrument, eROSITA, being provided by Germany and a medium-x-ray-energy survey instrument ART-XC being developed by Russia. ART-XC will consist of seven independent, but co-aligned, telescope modules. The NASA Marshall Space Flight Center (MSFC) is fabricating the flight mirror modules for the ART-XC/SRG. Each mirror module will aligned with a focal plane CdTe double-sided strip detectors which will operate over the energy range of 6-30 keV, with an angular resolution of <1', a field of view of 34' and the expected energy resolution about 10% at 14 keV.

Integration of X-ray telescope onboard VZLUSAT1 2U CubeSat

Vladimír Dániel

The wide-field X-ray optical system for space is commonly large in volume and mass. The aim of the work was to design the X-ray telescope suitable for 2U CubeSat nanosatellite. This contains not only miniaturization of optics and telescope volume, but also the detector and electronics selection. After the designing and analysing phase, the requirements leads to the novel approach of X-ray telescope. The proposed solution is based on the use of 1D "Lobster eye" optics in combination with Timepix X-ray non cooled detector in the energy range 3 - 40 keV. The presented X-ray telescope will be launched onboard technology demonstration mission VZLUSAT1 nanosatellite as a part of QB50.

Discussion on substrate thickness variation and coating deposition effects

Laura Proserpio

I will describe two aspects that are quite important in the production of thin x-ray mirrors: 1) the thickness variation of the substrates and its effects on the mirror being shaped; 2)the application of reflective coating and its effects on the shape of the substrate. Then, I will talk about the experience we have at MPE regarding this two topics: how we studied them in the past, what we are doing now, and how we plan to address them in the future. I will invite the participants of the conference to do the same in order to share our mutual experiences and stimulate the discussion.

Ionization instability in soft X-ray transients

Patrycja Bagińska

We study RXTE observations of the sample of black hole binaries, which possess X-ray novae outbursts in their light curves. Typically, one outburst occurs in collected light curves, with total duration from 30 up to 400 days. The shape of an outburst can be very regular fast rise and exponential decay (FRED) characteristic for ionization disk instability, or irregular suggesting that, beside FRED, additional flickering occurs. We compare observed time scales with those obtained from model computations done by Janiuk et al. 2002. The model calculates time dependent evolution of ionization instability in an accretion disk around black hole, assuming simple viscosity parametrization. By comparing data to model we will exam if observed outburst are really caused by ionization disk instability in selected objects.

Development of the X-ray Timing and Polarization telescope optics

Zhanshan Wang

X-ray Timing and Polarization (XTP) satellite, which uses focusing optics and advanced detector technology, is dedicated to the study of Black Hole, Neutron Star, Quark Star and the physics under extreme gravity, density and magnetism. With a detection area of ∼1 square meter, XTP will make the most sensitive temporal and polarization observations with good energy resolution in 1-30 keV. A recent overview on segmented glass optics for XTP Telescope is presented. The figure of the free-standing thin glass substrates, quality of grazing incident depth-graded multilayers and a mounting technology for the telescope has been improved. The metrology on glass figure, X-ray reflectivity and scatter of grazing incident depth-graded multilayers, and mounted structured optics will be shown. We also describe the plan for a prototype telescope to be constructed in the upcoming year.
Keywords: X-ray Timing and Polarization, depth-graded multilayers, telescope, grazing incidence, slumping glass, X-ray reflectivity

Contents

Václav Kobera, Space Activities in the Czech republic . . . 1
Rene Hudec, AXRO Introduction and Historical Background 1
Aschenbach Bernd, X-Ray Telescopes 1
Vladimir Karas, Predictions for the harmonic content of high-frequency quasi-periodic oscillations with LOFT . . . 1
Vojtech Simon, Examples of activity observed by the X-ray monitors 2
John Nousek, Physics of the Cosmos Program Analysis Group 2
Jiri Svoboda, Strong gravity with Athena 3
Maria Caballero-Garcia, The X-ray spectral and timing behaviour of the accreting pulsar V0332+53 3
Martin Topinka, X-ray Astrophysics 3
Hatem Ben loucaief, Results of experiments on the effect of x-ray on an amino acid 4
Marcos Bavdaz, Innovative X-ray Optics for the ESA Space Science Program 4
Marta Civitani, Slumped glass optics for future X-ray telescope: achievement and perspectives 5
Anita Winter, Indirect slumping of thin glass sheets for future X-ray telescope mirrors 5
Martin Míka, Optimizing thermal forming of glass and Si foils for x-ray telescope mirror 6
Mikhail Gubarev, X-ray Optics Development at MSFC . . . 6
Jackie Roche, Direct Polishing of Full-Shell, High-Resolution X-Ray Optics 7
William Zhang, Development of High-Resolution and Light-weight Astronomical X-ray Optics 7
Rene Hudec, Alternative Technologies for Large X-Ray Telescopes 8
Randall McEntaffer, Challenges Facing Soft X-ray Spectrometers 8
Richard Willingale, The narrow field lobster Eye Telescope for SVOM 9

Vladimír Tichý, Mathematical descriptions of multi-foil optics 9
Yuichiro Ezoe, Advances in MEMS X-ray optics 10
Ladislav Pina, Hard X-ray monitoring for astrophysical application 10
Aschenbach Bernd, RXJ0852.2-4622 alias Vela Jr. - the Remnant of the Nearest Historical Supernova: Impacting on the Present Day Climate? 11
John Nousek, Ten years of Swift 11
Yaser Hafez, New Astronomical Observations at wavelength range 1-4 nm above 46° 24' E, 24° 54' N 12
Bianca Salmaso, Advances in the hot slumping assisted by pressure 13
Vadim Burwitz, Developing, Testing and Calibrating the eROSITA and other X-ray Optics at PANTER 13
Vladimír Tichý, Optical study of nano-satellite x-ray monitor 14
Youness Bentahar, Atmospheric optics 14
Lorenzo Amati, Shading light on the cosmic dawn with THESEUS 15
Filippo Frontera, The X-γ-ray Spectrometer for THESEUS 15
Mikhail Pavlinsky, ART-XC telescope of SRG project, current status 16
Vladimír Dániel, Integration of X-ray telescope onboard VZLUSAT1 2U CubeSat 17
Laura Proserpio, Discussion on substrate thickness variation and coating deposition effects 17
Patrycja Bagińska, Ionization instability in soft X-ray transients 18
Zhanshan Wang, Development of the X-ray Timing and Polarization telescope optics 19