AXRO 2015
BOOK OF ABSTRACTS

Contents

AXRO Introduction and Historical Background

Rene Hudec

AXRO Introduction and Historical Background. I will very shortly introduce the history of development of astronomical X-ray optics in the Czech Republic and history of AXRO workshops.

Space Activities in the Czech republic

Václav Kobera

The AHEAD program in H2020 for integrating and opening European High Energy Astrophysics infrastructures

Lorenzo Natalucci

AHEAD (Integrated Activities in the High Energy Astrophysics Domain) is an ongoing project approved in the framework of the European Horizon 2020 program. Its overall objective is to integrate national efforts in High-Energy Astrophysics and to promote the domain at the European level, to keep its community at the cutting edge of science and technology and ensure that space observatories for high-energy astrophysics, with particular regard to Athena, are at the state of the art. AHEAD will integrate key research infrastructures for on-ground test and calibration of space-based sensors and electronics and promote their coordinated use. In parallel, the best facilities for data analysis of high-energy astrophysical observatories will be made available to the European community. The technological development will focus on the improvement of selected critical technologies, background modeling, cross calibration, and feasibility studies of space-based instrumentation for the benefit of future high energy missions like Athena, and the best exploitation of existing observatories. AHEAD will support the community via grants for collaborative studies, dissemination of results, and promotion of workshops. A strong public outreach package will ensure that the domain is well publicized at national, European and International level. Networking, joint research activities and access to infrastructures as devised in AHEAD, will serve to establish strong connections between institutes and industry for a more rapid advancement of high-energy astrophysical science, space oriented instrumentation, sensor and optics technology in Europe. This enables the development of new technologies and the associated growth of the European technology market, as well as the creation of a new generation of researchers.

X-ray Polarimetric Signatures of Black Holes at Centenary of EInstein's General Theory of Relativity

Vladimir Karas

Accretion onto black holes often proceeds via an accretion disc or a temporary disc-like pattern. Variability features observed in light curves, as well as theoretical models of accretion flows suggest that accretion discs tend to be inhomogeneous. Fast orbital motion of individual clumps can modulate the observed signal. If the emission from these clumps is partially polarized, which is likely the case, then rapid polarization changes of the observed signal are expected as a result of General Relativity (GR) effects. These changes should exhibit a specific dependence on energy. Although the geometrical effects of strong gravitational fields act on photons independent of their energy, the intrinsic emissivity of accretion discs and the influence of magnetic fields, intervening via Faraday rotation, are indeed energy dependent. As a result, the variability amplitudes of both the polarization degree the polarization angle must be energy dependent as well. These dependencies suffer from some degeneracy, which can be avoided with time-resolved observations. In this contribution we will sumarize the expected polarization properties at the 100th anniversary of GR. On the whole, there are some similarities as well as differences between the expected manifestation of GR polarization changes in X-rays and in other spectral bands, such as the infrared region. We will mention these synergies and point out that polarization measurements of the radiation flares from the immediate vicinity of the horizon are already now available for Sagittarius A* supermassive black hole in the Milky Way's center.

X-ray monitoring of cataclysmic variables - dependence on the instruments

Vojtech Simon

Monitors of X-ray emission are important instruments for observing the activity of binary X-ray sources with the mass accreting compact object on long timescales (months, years). This review will show that the profiles of features of the long-term activity of cataclysmic variables (CVs) are measurable by these monitors. We will emphasize that the available X-ray monitors can detect only CVs with magnetized white dwarfs, so the mode of accretion is very important for the detection. Only a radial flow onto the white dwarf causes sufficiently hard X-ray spectrum to be observable by the monitors with the available parameters. We will also show the possible ways of studying the faint X-ray CV emitters with the use of these data.

Ionized Keplerian disks creating relativistic jets

Zdenek Stuchlik

It is demonstrated that chaotic scattering in the black hole gravitational field combined with an uniform magnetic field enables energy interchange between the translational and oscillatory modes of charged particle motion providing an efficient mechanism for charged particle acceleration along the magnetic field lines. The chaotic scatter can cause energy transmutation to the motion along the magnetic field lines, with small radius of the Larmor motion or vanishing Larmor radius, when the speed of the particle translational motion is largest and can be ultra-relativistic. Ionization of test particles forming a neutral accretion disc, where no kick of heavy ions is assumed and only switch-on effect of the magnetic field is relevant, can lead to acceleration and escape of the ionized particles that can be efficient along the magnetic field lines parallel to the Kerr black hole symmetry axis. Strong acceleration of ionized particles to ultra-relativistic velocities is preferred in the direction close to the magnetic field lines, and the process of ionization of Keplerian discs around Kerr black holes can serve as a model of relativistic jets due to the transmutation energy effect.

Astrophysics of exotic stars: neutron stars in Be X-ray binaries

Maria D. Caballero-Garcia

Be/X-ray binary systems provide an excellent opportunity to study the physics around neutron stars through the study of the behaviour of matter around them. Intermediate and low-luminosity type outbursts are interesting because they provide relatively clean environments around neutron stars. In these conditions the physics of the magnetosphere around the neutron star can be better studied without being very disturbed by other phenomena regarding the transfer of matter between the two components of the Be/X-ray binary system. Our recent study presents the optical longterm evolution of the Be/X-ray binary V 0332+53 plus the X-ray emission mainly during the intermediate-luminosity outburst in 2008. In this talk we comment on the context of these observations and on the properties that can be derived through the analysis of them.

Resonant switch model applied to HF QPOs at atoll sources

Zdenek Stuchlik

The Resonant Switch (RS) model of twin high-frequency quasi-periodic oscillations (HF QPOs), based on switch of the twin oscillations at a resonant point, has been applied to the atoll source 4U 1636−53 where we observe two resonant points at frequency ratios $\nu_{\rm U} : \nu_{\rm L} = 3:2$, $5:4$. Dimensionless spin a and mass M governing the exterior geometry of the neutron star has been determined by fitting the pairs of the oscillatory modes admitted by the RS model to the observed data. The most promising variants of the RS model are those combining the Relativistic Precession (RP) and the Total Precession (TP) frequency relations or their modifications. The RS model then implies strong restrictions of the spacetime parameters M and a of the neutron star. The neutron star mass and spin estimates are then confronted to large variety of equations of state (EoS) governing structure of neutron stars in the framework of the Hartle–Thorne theory applied for the observationally given rotation frequency $f_{\rm rot} \sim 580\,{\rm Hz}$ (or alternatively $f_{\rm rot} \sim 290\,{\rm Hz}$) of the neutron star at 4U 1636−53. Only two variants of the RS model are compatible with the Hartle–Thorne theory, and that only the rotation frequency $f_{\rm rot} \sim 580\,{\rm Hz}$ can be relevant. The variant giving the best fit with the spacetime parameters $M \sim 2.2\,{\rm M}_\odot$ and $a \sim 0.27$ agrees with prediction of one of the Skyrme equations of state. The predictions based on the Kerr geometry describing the neutron star exterior are confirmed by the more exact modeling based on the Hartle-Thorne external geometry.

X-ray imaging of solar system bodies

Konrad Dennerl

Solar system bodies pose a particular challenge for X-ray imaging: their apparent size is either so small that they are difficult to resolve (planets) or so large that the emission may overfill the field of view (comets), their X-ray signal is extremely faint compared to their optical light, they move across the sky, and they may be located close to the Sun. On the other hand, such observations are scientifically most valuable, because they provide observational access to a variety of physical processes which are difficult or impossible to study by other means. The talk will summarize our current observational knowledge of the various sources of X-ray emission in the solar system and of the underlying physical processes.

Swift as a Rapid Wide Field Follow-up Instrument

John Nousek

The Swift Gamma-Ray Burst Explorer has reinvented our understanding of gamma-ray bursts by discovering and localizing more than 1000 bursts through extremely rapid follow-up. These capabilities have opened a new discipline of Time-Domain Astrophysics through the highly flexible, rapidly responsive and wide wavelength coverage of the Swift instruments. Even greater discoveries await from new observatories such as ALIGO and Virgo for gravitational waves, and IceCube for high energy neutrinos. Electromagnetic counterparts for these events are crucial for understanding the physics behind these new signatures. We have developed special operations to allow Swift to rapidly conduct hundreds of short observations to detect counterparts within the large and unusually shaped error regions resulting from these non-electromagnetic signals. I describe the new process and our plans for followup using Swift.

Testing Off-Plane Gratings for Polarization Sensitivity

Hannah Marlowe

Off-Plane reflection gratings offer a method to reach the high spectral resolution and throughput required by next generation X-ray observatories. Polarization sensitivity of gratings would introduce unique opportunities for future missions which utilize them. Off-plane gratings were previously predicted to have different efficiencies when the incident light is polarized in the transverse-magnetic (TM) versus transverse-electric (TE) orientations with respect to the grating grooves. However, more recent theoretical calculations which rigorously account for finitely conducting, rather than perfectly conducting, grating materials no longer predict significant polarization sensitivity. We present the first empirical results for radially ruled, laminar groove profile gratings in the off-plane mount which confirm no difference in TM versus TE efficiency across our entire 300-1500 eV bandpass. These measurements together with the recent theoretical results confirm that grazing incidence off-plane reflection gratings using real, not perfectly conducting, materials are not polarization sensitive.

Hard X-ray Focusing Optics for Solar Observations: The FOXSI concept

Krucker Säm

We will present an update on our efforts on the Focusing Optics X-ray Solar Imager (FOXSI) mission concept to observe our Sun with hard X-ray focusing optics. The FOXSI project is lead by the University of California at Berkeley, with hardware contribution form NASA Marshall Space Flight Center (grazing incidence optics) and the Astro-H team at JAXA/ISAS (double-sided strip detectors). This presentation will focus on results of the first two sounding rocket flights from November 2, 2012 and December 11, 2014, and we will give an overview of a FOXSI satellite concept that we will submit next year to the NASA Small Explorer (SMEX) call.

Four-times reflection X-ray optics and its application to X-ray telescope

Yuzuru Tawara

Effective area of the telescope for X-ray energy (E ¡ 10 keV) including iron K emission lines has been so far limited to about 1000 cm2 for assumed several meter focal length. However, if we introduce four-reflection optics to this energy range, we can get several times large effective area for single telescope with same several meter focal length. To prove this possibility, we performed ray tracing simulation for four-reflection telescope with 6 m focal length and found that effective area of 3100 cm2 at 6 keV can be obtained for single telescope. In this paper, we will discuss about other telescope performances, mechanical properties and application to fine spectroscopic mission using X-ray micro-calorimeter.

Development of Iridium coatings for X-ray mirrors at Aschaffenburg University

Doehring Thorsten

Previously used mirror technologies are not able to fulfil the challenging requirements of future X-ray telescopes. The high precision mirror manufacturing requires new technical developments. Some aspects of X-ray mirror production are studied within the recently started interdisciplinary project INTRAAST, an acronym for "industry transfer of astronomical mirror technologies". The project is embedded in a cooperation of the University of Applied Sciences Aschaffenburg and the Max-Planck-Institute for Extraterrestrial Physics. The goal of the project is to master the production of X-ray mirrors based on the hot slumping of thin glasses. As one project task the development of low stress Iridium coatings have been started at Aschaffenburg University. The corresponding technical approach, the experimental equipment, and first results will be presented.

Development of a high-performance X-ray telescope using the carbon fiber reinforced plastic

Ikuyuki Mitsuishi

Carolyn Atkins

Overview of differential deposition correction for astronomical X-ray optics at NASA MSFC

X-Ray Optics with Stacked Si Wafers

Rene Hudec

X-Ray Optics with Stacked Si Wafers will be presented and discussed. The improved Si wafers are of superior quality and are hence well suited for use in astronomical X-ray optics.They can be stacked to modules of various geometry. Very promising results were obtained for Si stacks in Kirkpatrick Baez geometry, but technologies for silicon wafer bending are also available for applications in geometries requiring bent substrates.

Indirect slumping technology development at MPE for the manufacturing of X-Ray optics

Laura Proserpio

An overview on the activities related to the development of the indirect slumping technology ongoing at Max Plank Institute for extraterrestrial physics (MPE) for the manufacturing of X-ray optics will be presented. The latest results on slumping, coating and integration will be shown and the path toward further progress will be outlined. I will give the first part of the presentation on the current status of the study, showing the latest prototype modules of segmented glass optics integrated at MPE. The second part of the presentation will be given by Mingwu Wen on a recently introduced new approach for the slumping phase.

Indirect slumping technology development at MPE for the manufacturing of X-Ray optics

Mingwu Wen

An overview on the activities related to the development of the indirect slumping technology ongoing at Max Plank Institute for extraterrestrial physic (MPE) for the manufacturing of X-ray optics will be presented. The latest results on slumping, coating and integration will be shown and the path toward further progress will be outlined. The first part of the presentation will be given by Laura Proserpio and will focused on the current status of the study, showing the latest prototype modules of segmented glass optics integrated at MPE. I will give the second part of the presentation on a recently introduced new approach for the slumping phase. Furthermore, I will update you on the latest activities ongoing in Tongji University in Shanghai on XTP (X-ray Timing and Polarization).

Cold and hot slumping glass technologies for making grazing incidence x-ray optics

Marta Civitani

Since several years, the hot slumping glass optics (SGO) technology is studied at INAF/OAB for the realization of segmented X-ray optics, a to be assembled togheter in a common structure to realize X-ray telescopes (that can have apertures up to a couple of meters) . The integration technique is based on the cold shaping of glass segments (previously produced with hot slumping in cylindrical configuration) and it forsees the use of connecting/reinforcing of ribs. Last advancements in the production of thin glass substrates may allow a great simplification of this process, depending also on the angular resolution requirement to be achieved. High quality thin substrates are now available and this may allow to starting directly from flat glass segments for the integration, avoiding the pre-forming step via hot slumping. In fact, the thickness, the strength and the flexibility of these glass foils (with thickness lower than 0.030 mm) allow their bending up to very small radius of curvature without breaks. In this talk we will provide an overview of the different concepts for the production of X-ray astronomical optics via glass slumping and how they can be used for the manufacturing of future X-ray telescopes.

Future perspectives for large-area X-ray timing instruments

Marco Feroci

In this talk I will discuss possible options for future large-area experiments/missions devoted to spectral-timing investigations in the 0.5-30 keV energy range currently under study in Europe. Prime science goals for such missions is the study of matter under extreme conditions of gravity (strong-field regime) and density (ultra-dense matter).

Design of MFO imaging system for Cubesat project

Ladislav Pina

ATHENA – Overview of the Assessment/Definition Phase

Mark Ayre

ATHENA has recently been selected for the 'L2' slot in ESA's Cosmic Vision Programme, with a mandate to address the 'Hot and Energetic Universe' Cosmic Vision science theme. The mission is currently in Phase A, with a view to formal adoption after a successful System Requirements Review. This paper will describe the current reference mission architecture and spacecraft design produced during Phase 0 of the study by the ESA Concurrent Design Facility (CDF), in response to the technical requirements and programmatic boundary conditions. The main requirements and their mapping to resulting design choices will be presented, at both mission and spacecraft level. An overview of the spacecraft design down to subsystem level will then be presented (including the telescope and instruments), touching upon the critically-enabling technologies where appropriate. Particular emphasis will be placed on the design choices made in response to the angular resolution requirements of the telescope (5" Half-Energy Width), the astrometry (3" Absolute Knowledge Error) and related pointing requirements, and the requirement to rapidly respond to the majority of Target-of-Opportunity requests (within 4 hours from receipt of the request for 80% of instances). Finally, a programmatic overview will be given of the on-going assessment/definition phase (A/B1), including the technology development effort, targeting mission adoption in 2019/2020.

Silicon Pore Optics development for ATHENA

Max Collon

The ATHENA mission, a European large (L) class X-ray observatory to be launched in 2028, will essentially consist of an X-ray lens and two focal plane instruments. The lens, based on a Wolter-I type double reflection grazing incidence angle design, will be very large ($\sim$ 3 m in diameter) to meet the science requirements of large effective area (1-2 m2 at a few keV) at a focal length of 12 m. To meet the high angular resolution (5 arc seconds) requirement the X-ray lens will also need to be very accurate. Silicon Pore Optics (SPO) technology has been invented to enable building such a lens and thus enabling the ATHENA mission. We will report in this paper on the latest status of the development.

AHEAD: Studying X-ray Optics technologies

Vadim Burwitz

As part of the the EU funded AHEAD project a work package dedicated to studying the different X-ray optics technologies in general has been setup. A comparison of optics simulations with tests of manufactured optics for will done at the PANTER. Furthermore techniques for generating a parallel beam for testing Athena type optics modules will be studied and a prototype facility setup and tested in the context.

A realized large area X-ray collimator to measure SPOs

Benedikt Menz

A collimator, that parallelizes an X-ray beam, provides a significant improvement of the metrology to characterize X-ray optics for space instruments at MPE's PANTER X-ray test facility. A Fresnel zone plate was selected as a collimating optic, as it meets a good angular resolution <0.1 arc sec combined with a large active area ¿10 cm^2. Such an optic is ideally suited to illuminate Silicon Pore Optic (SPO) modules as proposed for ATHENA. We present such a zone plate collimator in theory and experiment. Based on the requirements to characterize ATHENA type SPOs a zone plate collimator has been manufactured, calibrated, and used to illuminate an X-ray optic with a parallel beam. The results show that a zone plate collimator is not only feasible but also improves the measurement setup.

XIPE: The X-ray Imaging Polarimetry Explorer. Opening a new window with a medium-class ESA mission

Gianpiero Tagliaferri

X-ray polarimetry allows to answer, in a novel way, at questions related to the acceleration phenomena, to the transport of radiation in plasma embedded in a strong magnetic field, to questions related to the scattering in a-spherical geometries, and, finally, to questions of fundamental physics. Since the dawn of X-ray astronomy it has been clear the value of polarimetry in this energy range but the available techniques have always been the major limitation. Modern photoelectric X-ray polarimeters, based on the Gas Pixel Detector (GPD) technologies, overcame these limitations allowing for a sensitive measurement on hundreds of sources. XIPE (the X-ray Imaging Polarimetry Explorer), now in a study phase for ESA, will be operated as a conventional X-ray observatory, providing polarimetry simultaneously to the usual imaging, temporal and spectral information. This is made possible by its unique payload configuration consisting of three GPDs at the focus of three X-ray telescopes, that will fit within the Vega launcher. In this talk I will describe the XIPE properties and the major scientific objectives for X-ray polarimetry that will be made possible by XIPE.

ART-XC/SRG

Mikhail Pavlinsky

Looking Forward to Future Soft X-ray Spectroscopy Missions

Randall McEntaffer

In the coming decades, the field of X-ray astronomy desires to accomplish several key science goals. Current X-ray observatories are incapable of addressing many of these including detailing the distribution of hot matter in the Universe. A large fraction of baryonic matter is theorized to exist in between galaxies. Detection of this matter and characterizing feedback mechanisms from galaxies are substantial advancements of our understanding that can be realized through soft X-ray spectroscopy. Future X-ray missions require diffraction gratings with high throughput and high spectral resolving power to achieve these goals. Recent advances in grating fabrication methods have enabled reflection gratings to obtain the necessary performance requirements. I will discuss these novel fabrication methods and detail our progress in fabricating custom grating groove profiles. These gratings have demonstrated very high X-ray diffraction efficiency and spectral resolving power during X-ray testing. I will detail these results and describe current and future space based applications of spectrometers based on such gratings.

Status Update on the Adjustable X-ray Optics Program

Ryan Allured

I will review the current status of the adjustable X-ray optics program in support of the X-ray Surveyor mission concept. Overall program status and future plans will be presented, followed by a more detailed discussion of recent mirror actuation experiments.

Active optics systems at FERMI Free Electron Laser

Lorenzo Raimondi

FERMI is the first seeded EUV-SXR free electron laser (FEL) user facility operated at Elettra Sincrotrone Trieste. Two of the three already operating beamlines, namely LDM (Low Density Matter) and DiProI (Diffrac- tion and Projection Imaging), use a Kirkpatrick-Baez (K-B) active X-ray optics system for focusing the FEL pulses onto the target under investigation. For the third beamline, TIMEX, we have installed an ellipsoidal mirror as focusing system, and in addition we are also developing an active optics system to be mounted along this beamline, in order to properly shape the spatial photon beam profile at the sample. In the present work, first we report on the final results obtained from the optimization of the K-B optical system at the DiProI endstation. The aim of the optimization is to improve the system performances in terms of quality and size of the focal spot onto the sample, controlling the fluence as well. To characterize the performances and develop reliable and reproducible focusing procedures we performed a campaign of measurements with several diagnostic systems, including a wavefront sensor mounted after the DiProI chamber. Online wavefront measurements have made possible the optimization of the bending acting on the mirror curvature and of the (pitch and roll) angle positions of the K-B system. From the wavefront measurements we have inferred a focal spot of 5 μm x 6 μm, confirmed by the PMMA ablation imprints. The experimental results are compared with the predictions from simulations obtained using the WISE code, starting from the characterization of the actual mirror surface metrology. The results from simulations are in agreement with the experimental measurements. In the second part of this work, we present the very first measurements in terms of metrology characterization of the beam shaping active optics system. The resulting profiles, after a deliberate deformation of the mirror, have been characterized with a Long Trace Profiler and compared with the estimation profiles obtained with the

strain gauge mounted under the mirror. Then, the profiles were correlated with the expected focal spot shape obtained via WISE code. The first result achieved in this first test phase is the obtaining of a particular focal spot shape prefixed (simulated) through a deformed mirror profile.

Laser plasma EUV sources for application in test facilities

Henryk Fiedorowicz

Extreme ultraviolet (EUV) test facilities are needed to characterize space optical instruments operating in this spectral range. The FOCAL X facility at Centre Spatial de Liege (CSL) was used in the X-ray Multi Mirror Mission (XMM) test programme and a new EUV test facility at the Marshall Space Flight Center (MSFC) is being developed to test EUV telescopes for the High Resolution Coronal Imager (Hi-C) and the Solar Ultraviolet Imager (SUVI) missions. The CSL facility was equipped with a EUV electron cyclotron resonance helium source emitting 8x1015 photons/(sec.sr) at the wavelength of 58.4 nm (He I line) and 1x1015 photons/(sec.sr) at the wavelength of 30 nm (He II line). The MSFC facility is equipped with a discharge plasma EUV source from AIXUV emitting 6x1014 photons/(sec.sr) at the "average" wavelength of 15nm and 100 Hz repetition rate. In this paper we propose the use of laser plasma EUV sources instead of a discharge plasma source. Laser plasma sources generate EUV radiation in the same spectral range, however, have a smaller source size and a higher brightness. EUV radiation is produced in a laser plasma created by the interaction of a nanosecond laser pulse with an energy of about 1-10J with a target in the form of a solid material, liquid jet or gas flow at high pressure (gas puff target). The EUV sources developed at our laboratory for application in various areas of technology and science are presented. The sources are based on a laser-irradiated gas puff target. The targets formed by pulsed injection of gas under high-pressure are irradiated with laser pulses from commercial Nd:YAG lasers generating 4 ns pulses with energy of about 0.8 J or pulses with time duration of 10 ns and energy of 10J at 10Hz repetition rate. Assuming 10efficiency of the conversion of laser energy to EUV energy, that is practically achievable value, one can expect production of about 5x1015 photons/(sec.sr) at the "average" wavelength of 15nm for laser pulses with energy of 0.8 J and 6.2x1016 photons/(sec.sr) for pulses

with energy of 10 J. Characterization measurements of these sources and their application in various fields, including imaging in nanoscale, pulsed radiography and tomography, processing of materials and modification of polymer surfaces, photoionization of gases, and radiobiology will be presented and the possibility of the use in EUV test facilities will be discussed.

An overview of SMILE (Solar wind Magnetosphere Ionosphere Link Explorer)

Graziella Branduardi-Raymont

SMILE[1] is a novel self-standing space mission dedicated to study the solar wind – Earth's magnetosphere coupling by obtaining X-ray images of the magnetosheath and polar cusps, and UV images of global auroral distributions, simultaneously with in situ solar wind/magnetosheath plasma and magnetic field measurements. For the first time we will be able to trace and link the processes of solar wind injection in the magnetosphere with those acting on the charged particles precipitating into the cusps and eventually the aurora. X-ray imaging of the dayside magnetosheath and cusps has been made possible thanks to the relatively recent discovery of solar wind charge exchange (SWCX) X-ray emission, first observed at comets, and subsequently found to occur in the vicinity of the Earth's magnetosphere. SMILE is the first fully collaborative space mission from inception to implementation and operations between ESA and the Chinese Academy of Sciences (CAS). This talk will present the science and the impact that SMILE will deliver, and will provide an overview of its payload and of the mission's development.

[1] http://www.mssl.ucl.ac.uk/SMILE/

The Soft X-ray Imager (SXI) on SMILE

Steven Sembay

SMILE (Solar Wind Magnetosphere Ionosphere Link Explorer) is a space mission dedicated to study the interaction of the solar wind with the Earth's magnetic field. SMILE will investigate the dynamic response of the Earthś magnetosphere to the impact of the solar wind in a unique manner, never attempted before: it will combine soft X-ray imaging of the Earthś magnetic boundaries and magnetospheric cusps with simultaneous UV imaging of the Northern aurora, while simultaneously probing the conditions of the solar wind with an in situ measurement package. SMILE was proposed as a candidate for the joint European Space Agency (ESA) and Chinese Academy of Sciences (CAS) announcement of opportunity in January 2015. Out of 13 missions originally proposed, SMILE is the one selected for an initial study phase during the second half of 2015, with a final decision for implementation due in Nov. 2015. This talk will describe the Soft X-ray Imager (SXI) on SMILE. The SXI is designed for good detection sensitivity of the soft X-rays (0.2 – 2 keV) produced in the Earth's exosphere by the solar wind charge exchange process. The wide FOV (25° x 22°) is achieved by the use of a micropore optic (MPO) with a Lobster focusing geometry. The detector is a CCD array providing high quantum efficiency and medium energy resolution for soft X-rays.

NASA Opportunities through the Physics of the Cosmos Program

John Nousek

Paul Hertz, Director of NASA's Astrophysics Division, has publicly presented his evolving strategy to advance astrophysics through a carefully articulated plan covering the next five years (2016-2020). Highlights of this plan include a CAA assessment of NASA's execution of the last Decadal Survey (New Worlds, New Horizons), and the associated technology development and program solicitation opportunities, which will define how future missions after James Webb Space Telescope will be created. From my perspective as member of the Astrophysics Subcommittee and ex officio Chair of the Physics of the Cosmos Program Analysis Group, I will describe how I see this plan providing the context for astrophysical instrumentation and missions in the near future.

The Hinode X-Ray Telescope (XRT)

Mark Weber

The Hinode X-Ray Telescope (XRT) is a high-resolution grazing-incidence telescope, which is a successor to the highly successful Yohkoh Soft X-Ray Telescope (SXT). High-resolution soft X-ray images reveal magnetic field configurations and their evolution, allowing us to observe the energy buildup, storage, and release process in the corona for any transient event. One of the unique features of XRT is its wide temperature coverage to see all the coronal features that are not seen with any normal incidence telescope. The XRT was designed and developed by the Japan-US collaboration between Smithsonian Astrophysical Observatory (SAO), NASA MSFC, JAXA, and NAOJ. The XRT project is supported by contract NNM07AB07C from MSFC/NASA to SAO.

THESEUS Project

Rene Hudec

I will shortly present the THESEUS project considered for ESA M5 call along with proposed Czech participation. THESEUS is designed to vastly increase the discovery space of the high energy transient phenomena over the entirety of cosmic history. Its primary scientific goals will address the Early Universe ESA Cosmic Vision theme "How did the Universe originate ad what is made of?". 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 providing large grasp and high angular resolution; and 3) on board near-IR capabilities for immediate transient identification and redshift determination.

The X-ray Surveyor: Successor to the Chandra X-ray Observatory

Dan Schwartz

Sixteen years of sub-arcsecond images with the Chandra telescope have established the crucial contributions which X-ray observations can make to all topics in astrophysics. To realize orders of magnitude advance, NASA plans to study an X-Ray Surveyor to present as a possible 2020s mission for consideration by the 2020 Decadal Survey of Astronomy and Astrophysics. The science advances require sub-arcsecond angular resolution, order of magnitude increase of collecting area, and advances in X-ray spectroscopy, camera bandwidth and efficiency, and counting rate capabilities. Conceptually, the X-ray mirror and focal plane instruments are plug-in replacements for the Chandra mirror and cameras. I will describe some science drivers, and a realistic spacecraft and mission concept for the next decade.

Development of Precision Wolter Mirrors for Future Observations of the X-ray Sun

Taro Sakao

High resolution imagery of solar X-ray corona provides a crucial key to understand dynamics and heating processes of plasmas there. However, X-ray imagery of the Sun with sub-arcsecond resolution has yet to be conducted due to severe technical difficulty in fabricating precision Wolter mirrors. For future observations of the X-ray Sun, we are attempting to realize precision Wolter mirrors with sub-arcsecond resolution by adopting advanced surface polish and measurement methods to sector mirrors which consist of a portion of an entire circle. Focusing performance of an engineering mirror fabricated early this year was evaluated at SPring-8 synchrotron facitily with 8-keV monochromatic X-rays. The mirror achieved 0.2-arcsec FWHM size for the PSF core for both sagittal and meridional focusing. On the other hand, its HPD size remained at $\sim$3 arcsec due to the presence of small-angle scattering outside the core originated by the figure error of the mirror at a spatial scale around 1 mm. Ongoing development activities for precision Wolter mirrors will be presented together with X-ray measurement results.

Opening the Field of Soft X-ray Polarimetry

Herman Marshall

We present development of a telescope for measuring linear X-ray polarization over the 0.2-0.8 keV band. 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%. We have constructed a source of polarized X-rays that operates at a wide range of energies with a selectable polarization angle. Previously, we demonstrated that the polarimetry beam-line provides 100% polarized X-rays at 0.525 keV (Marshall et al. 2013). Recently, we upgraded the source by installing a mirror with a laterally graded multilayer (LGML) coating, providing a wide energy range. We will present results from continued development of LGMLs and new gratings. Finally, we will present a design for a small telescope for suborbital or orbital missions. A suborbital mission could measure the polarization of a blazar such as Mk 421 to 5-10 percent while an orbital version could measure the polarizations of neutron stars, active galactic nuclei, and blazars.

Miniaturized X-ray telescope CubeSat mission VZLUSAT-1

Vladimír Dániel

The VZLUSAT-1 nanosatellite status as a part of the QB50 mission will be presented. The 2U technological CubeSat spacecraft will be described with the demonstrator of miniaturized x-ray telescope. The mission topics will be presented i.e. space weather monitoring, solar monitoring, background radiation measurement and astrophysical observation.

Feasibility study for setting up a radio telescope in Nigeria for space and VLBI research

Olutayo Victor Olayeni

To determine a suitable radio telescope for space and VLBI research at an affordable cost, we considered; a parabolic radio telescope, a cylindrical radio telescope and arrays of both parabolic and cylindrical radio telescopes. This we did by comparing the advantages and disadvantages of these radio telescopes, calculating their parameters using established mathematical methods and their cost estimates. Though a radio telescope suitable for space and VLBI research must be as large as possible, to achieve a balance between performance and economics a 25m parabolic antenna radio telescope at a cost of N1.76 billion (US$13.968 million) was considered suitable to be set up. A consideration of the parameters of the proposed site at Ebilimmiri showed that the site is radio quiet, though not quite in a valley. A careful analysis show that this telescope can be used to carry out sky survey at a given frequency, observe interplanetary scintillations (IPS) of distant radio sources, provide information on solar wind velocity and with a resolution, ranging from 0.01o at λ = 1cm (30Ghz) to 0.3o at λ = 30cm (1Ghz), the telescope will be very effectively used for studying a variety of solar and planetary radio bursts. The telescope can equally be used as a VLBI technique with the radio telescope in Hartebeesthoek in South Africa. The maintenance of the Radio telescope will not pose so much problems considering the MoU signed with National Astronomical Observatory, Japan which includes capacity building and manpower development programme which the Centre for Basic Space Science has embarked upon.

VZLUSAT-1 image processing

Martin Blazek, Tomas Baca

Nanosatellite VZLUSAT-1 has onboard X-ray "Lobster eyöptics and we present the image processing, algorithms, current status and future ideas of imaging system.

Development of an X-ray telescope with a large effective area for the Iron K line band

Ikuyuki Mitsuishi

Space measurement on VZLUSAT-1 Evaporation of CFRE material

Martin Urban, Ondrej Nentvich, Veronika Stehlikova, Ladislav Sieger

This poster talks about evaporation measurement on orbit. This payload is placed onboard of Nanosatellite VZLUSat-1. There are described humidity sensors and results of their calibration for space environment.

Space measurement on VZLUSAT-1 Mechanical properties of CFRE

Martin Urban, Ondrej Nentvich, Veronika Stehlikova, Ladislav Sieger

This poster talks about measurement of Carbon fibre material, which is tested on orbit on nanosatellite VZLUSAT-1. There are described process of measurements and their results.

Space measurement on VZLUSAT-1 Radiaton endurance of CFRE

Martin Urban, Ondrej Nentvich, Veronika Stehlikova, Ladislav Sieger

This poster talks about measurement of radiation shielding. Quality of shielding is important for longterm application on orbit.

Ryan Allured - Smithsonian Astrophysical Observatory
Carolyn Atkins - University of Alabama in Huntsville
Mark Ayre - ESA
Martin Blazek - Czech Technical University
Graziella Branduardi-Raymont - Mullard Space Science Laboratory - UCL
Vadim Burwitz - MPI für extraterrestrische Phyysik
Maria D. Caballero-Garcia - ASU-CAS (Prague)
Marta Civitani - INAF-OAB
Ngana Jules Claude - UNIVERSITY OF YAOUNDE
Max Collon - cosine BV
Vladimír Dániel - Aerospace research and test establishment
Konrad Dennerl - MPE
Henryk Fiedorowicz - Institute of Optoelectronics, Mil Univ Technol
Roland Graue - OHB System AG
Mikhail Gubarev - NASA/MSFC
Yaser Hafez - KACST
Rene Hudec - ASU AV CR & CTU
Adolf Inneman - Czech Technical University in Prague
Vladimir Karas - Astronomical Institute, Czech Academy of Sciences
Shant Khlghatyan - MIPT
Václav Kobera - Ministry of Transport
Martin Komarek - L.K. Engineering
Hatem Ben loucaief - Faculté de sciences de monastir
Hannah Marlowe - University of Iowa
Herman Marshall - MIT Kavli Institute
Veronika Maršíková - Czech Technical University in Prague
Randall McEntaffer - University of Iowa
Benedikt Menz - Max-Planck-Institut für extraterrestrische Physik
Ikuyuki Mitsuishi - Nagoya University
Lorenzo Natalucci - INAF
Ondřej Nentvich - CTU FEE
Akpwa Ngono Francine Noelle - UNIVERSITY OF YAOUNDE

John Nousek - Penn State University
Olutayo Victor Olayeni - UNIVERSITY OF IBADAN, Nigeria
Mikhail Pavlinsky - IKI RAS
Ladislav Pina - Czech Technical University in Prague
Laura Proserpio - MPE - Max-Planck-Institut für extraterrestrische Physik
Lorenzo Raimondi - Elettra-Sincrotrone SCpA
Rajeev Singh Rathour - Indian Institutes of Science Education and Research (IISER) Pune
Taro Sakao - ISAS/JAXA
Vratislav Šálený - Sobriety s.r.o.
Krucker Säm - University of Applied Sciences Northwestern Switzerland
Dan Schwartz - Smithsonian Astrophysical Observatory
Steven Sembay - University of Leicester
Vojtech Simon - Astronomical Institute CAS & CTU in Prague
Michaela Skulinova - ASU/Université de Montréal/CSA
Veronika Stehlikova - CVUT FEL
Zdenek Stuchlik - Faculty of Philosophy and Science, Silesian University at Opava
Gianpiero Tagliaferri - INAF - Osservatorio Astronomico di Brera
Yuzuru Tawara - Nagoya University
Yuzuru Tawara - Nagoya University
Doehring Thorsten - Hochschule Aschaffenburg
Martin Urban - CTU FEE
Petr Vana - Sobriety s.r.o.
Dervis Vernani - RUAG Space
Standa Vitek
Mark Weber - Harvard-Smithsonian CfA
Mingwu Wen - MPE - Max-Planck-Institut für extraterrestrische Physik
William Zhang

AXRO 2015 http://axro.cz

8th International Workshop on Astronomical X–Ray Optics

December 7-10, 2015
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:

Veronika Marsikova (chair), [v.semencova@gmail.com]
Michaela Skulinova, AI AS CR Ondrejov & CSA
Martin Blazek, CTU Prague

Program Committee:

Assoc.Prof. Rene Hudec (chair) [rene.hudec@gmail.com]
Prof. Martin Elvis
Prof. Richard 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
Dr. Stanislav Vítek

Publishing :

Martin Blazek & Nada Karlicka