

International Workshop on Astronomical X-Ray Optics 2008
Villa Lanna, Prague
December 2. – 6.

2. December

15.00 Registration starts

16.00 Welcome Cocktail

3. December

I. Session on Astrophysics with Astronomical X-ray Telescopes

8.45 – 9.00 Opening workshop and Welcome notes

9.00 – 9.30 Martin Elvis - The Discovery Space Argument for Large High Resolution X-ray Optics

9.40 – 10.10 Giuseppina Fabbiano - X-ray observations of galaxies

10.20 – 10.40 **Coffee Break**

10.40 – 11.00 Vadim Arefiev - X-ray variability and viscous time scale at accretion disks

11.10 – 11.35 Petr Hadrava - X-ray and H-alpha variability of Cyg X-1

11.45 – 12.15 Vojtech Simon - Long-term activity of binary X-ray sources: the importance of monitoring

12.25 – 14.00 **Lunch**

14.00 – 14.30 Ingo Kreykenbohm - Highly structured wind in Vela X-1

14.40 – 15.10 Jiri Horak - Polarization from radiatively accelerated flows

15.20 – 16.00 **Coffee Break + poster session**

16.00 – 16.45 Randall L. McEntaffer - High Resolution Soft X-ray Spectroscopy of Supernova Remnants

16.55 – 17.15 Richard Willingale - X-ray Telescopes in Action

17.25 – 17.55 Martin Elvis - Quasars and Active Galactic Nuclei with a large area, high resolution X-ray Telescope

Poster Session

15.20 – 16.00 Jiri Svoboda - Comparison of relativistic iron line models

Tomáš Pecháček - Hot-spot model for accretion disc variability as random process

Matus Kocka - Robotic optical telescopes as ground-based support for X-ray telescopes

Vladimir Karas - X-ray spectra and polarization from accreting black holes -- Signatures of a rotating black hole

Monika Vongehr - Experimental and ongoing studies on segmented X-Ray optics made of slumped glass

Martina Landova - Thermal Forming of Glass Foils for X-ray Space Telescopes

Michaela Skulinova - Alternative materials in view of new light weight X-ray optics

4. December

II. Session on Astronomical X-Ray Optics

9.00 – 9.30 Rene Hudec - Astronomical X-Ray Optics in the Czech Republic: Past, Present, Future

9.35 – 10.05 William W. Zhang - Lightweight and High Angular Resolution X-Ray Optics for the International X-ray Observatory

10.10 – 10.30 Rene Hudec- New Technologies for Future Space X-Ray Telescopes

10.35 – 10.55 **Coffee Break**

10.55 – 11.25 Libor Sveda - Lobster Eye Imaging Properties

11.30 – 12.00 Giovanni Pareschi - SIMBOL-X: A FORMATION FLIGHT MISSION WITH AN UNPRECEDENTED IMAGING CAPABILITY IN THE 0.5-80 KEV ENERGY BAND BASED ON NI ELECTROFORMED OPTICS

- 12.05 – 12.25 Brian Ramsey - New Developments for Electroformed Nickel Optics
- 12.30 – 12.45 Veronika Semencova – Galvanoplastic replication
- 12.50 – 14.15 **Lunch**
- 14.30 – Departure to the Astronomical Institute in Ondrejov followed by the visit of Chateau Komorni Hradek where the Chateau tour, Concert and then Conference dinner will take place. Estimated return to Prague is around 12 p.m.

5. December

II. Session on Anomical X-Ray Optics

- 9.00 – 9.10 Rene Hudec - Active X-ray optics
- 9.15 – 9.45 Martin Hromcik - Control systems for adaptive X-ray optics
- 9.50 – 10.20 Dan Schwartz - Generation-X telescope: measurement of on-orbit adjustment data
- 10.25 – 10.40 George Fraser – Advances in lead silicate glass microchannel plate optics
- 10.45 – 11.05 **Coffee Break**
- 11.05 – 11.25 Richard Willingale - Kirkpatrick-Baez Silicon Stacks for IXO or similar applications
- 11.30 – 11.50 Jan Sik - Advanced Si wafers for X-ray telescopes
- 11.55 – 12.10 Rene Hudec - Wide-Field Lobster-Eye X-Ray Telescopes & MFO Optics
- 12.15 – 12.35 Paul Reid - Development of advanced grazing incidence optics at the Smithsonian Astrophysical Observatory
- 12.40 – 13.50 **Lunch**
- 13.50 – 14.10 Ondrej Gedeon - Changes in glass irradiated with an electron beam
- 14.15 – 14.40 Yuichiro Ezoe - Development of hot plastic deformation of silicon for X-ray pore optics

- 14.45 – 15.05 **Coffee Break**
- 15.05 – 15.25 Webster Cash - Reflection Grating Optics
- 15.30 – 15.50 Mauro Ghigo - Slumped glass option for making the IXO mirrors
- 15.55 – 16.15 Martin Mika - Aspects of Glass Foils Thermal Forming for X-ray Telescopes Mirrors

16.45 Guided Excursion "Astronomical Prague" led by Dr. Alena Solcova, specialists for the history of Astronomy in Prague

6. December

II. Session on Astronomical X-Ray Optics

- 9.00 – 11.30 Round table discussion
- 11.30 – 12.00 Conclusions and closing of the workshop

The Discovery Space Argument for Large High Resolution X-ray Optics

Martin Elvis

Chandra has discovered a wealth of new phenomena in the X-ray sky. Here I note some of the highlights from Chandra and see how they will be quantitatively and qualitatively surpassed by an X-ray telescope with a factor 5-10 time better angular resolution and an order of magnitude or more increase in effective area.

X-ray observations of galaxies

Giuseppina Fabbiano

High resolution X-ray observations of galaxies with Chandra have opened a new era for the study of their X-ray components and evolution. In particular, X-ray binary evolution can now be addressed directly from the study of populations of these sources in different types of galaxies and environments; the properties of massive nuclear black holes and their effect on the host galaxy can be explored with direct observations of these regions; and the overall galaxy evolution can be constrained by means of deep sky surveys. To advance these observations from exploratory projects to full-fledged astronomical studies, future X-ray optics need to be developed with sub-arcsecond resolution and large collecting areas.

X-ray variability and viscous time scale at accretion disks

Vadim Arefiev, Mikhail Pavlinsky, Marat Gilfanov, Lev Titarchuk

We present analysis of nonperiodic variations of X-ray radiation from LMXBs. This variability is governed by diffusion propagation of density perturbations to main energy release zone near the accreting object. We show that the shape of X-ray power density spectra is sensitive to viscous time scale of the whole accretion disk.

X-ray and H-alpha variability of Cyg X-1

Petr Hadrava

Variability of Cyg X-1 observed in H-alpha line using Ondrejov 2-m telescope is compared with RXTE observations. It is shown that the line-profile can be decomposed to P-Cyg profile of the supergiant and an emission peak radiated by circumstellar matter. The EW of the later component is responsible for the anticorrelation of the X-ray flux and the H-alpha emission.

Long-term activity of binary X-ray sources: the importance of monitoring

Vojtěch Šimon

We discuss the long-term activity of binary X-ray sources, namely low-mass X-ray binaries and cataclysmic variables. We show that dense series of observations covering the intervals of several years are necessary to resolve the state transitions, like rising and decaying branches of outbursts and high/low states. This is important for our understanding of the physical processes involved. We emphasize the very important role of X-ray monitors like ASM onboard RXTE on our understanding of the processes operating in X-ray sources. We argue in favor of the development of more sensitive X-ray monitors that will be able to detect the long-term activity of cataclysmic variables, since the current ASM/RXTE is able to observe only about three such systems.

Highly structured wind in Vela X-1

Ingo Kreykenbohm, Jörn Wilms, Peter Kretschmar, Jose Miguel Torrejon, Katja Pottschmidt, Manfred Hanke, Andrea Santangelo, Carlo Ferrigno, Rüdiger Staubert

I present the results of an in-depth analysis of the spectral and temporal properties of a two week long uninterrupted INTEGRAL observation of Vela X-1 in Nov/Dec 2003. In addition to an already high activity level, Vela X-1 exhibited several very intense flares with a maximum intensity of more than 5 Crab in the 20–40 keV band and unexpected off states where the source became undetectable with ISGRI. I discuss a possible scenario to explain these off states and flares in the frame work of a strongly structured wind of the donor star: The neutron star can encounter cavities with a strongly reduced density as well as dense blobs of material. When the neutron star enters such a cavity, the accretion rate will drop, thus potentially triggering the onset of the propeller effect, which then inhibits further accretion. At the same time, this structured wind can also give rise to giant flares when a large blob of dense material is accreted. Further temporal analysis revealed that a short lived QPO with a period of ~ 6800 sec is present in the light curve. The part of the light curve during which the QPO is present is very close to the off states and just following a high intensity state, thus showing that all these phenomena are related.

Polarization from radiatively accelerated flows

Jiří Horák, Vladimir Karas

We study linear polarization from the Thomson scattering of light on a cloud with relativistic electrons. We derived simple and general analytical formulae for the frequency-integrated Stokes parameters describing local intensity and polarization of the scattered radiation. These formulae are then used in calculations of the temporal evolution of the observed light from the cloud moving under combined influence of the radiation and gravitational fields in the vicinity of accreting black holes. Under suitable geometrical conditions the observed radiation can be significantly contributed by higher-order images arising due to gravitational bending of light rays. Possible targets are super-massive black holes or Galactic microquasars exhibiting episodic accretion/ejection events

High Resolution Soft X-ray Spectroscopy of Supernova Remnants

Randall McEntaffer

Supernovae and their remnants greatly influence the dynamics within the interstellar medium. Their ubiquitous nature and size allow them to influence multiple phases of the ISM while influencing the evolution and structure of the Galaxy. The physical characteristics in the hot plasma of supernova remnants can be discerned through high resolution X-ray spectroscopy. Diagnostic lines of astrophysically abundant elements are prominent at soft X-ray energies, below 1 keV. Prior to IXO and Gen-X, ultra high spectral resolution in this band was unrealizable. This talk will summarize the potential of the X-ray Grating Spectrometers onboard these future observatories as it pertains to galactic supernova remnants.

X-ray Telescopes in Action

Richard Willingale

I will review the development of X-ray telescopes hand-in-hand with the development of X-ray astronomy. Over four decades the size, complexity and performance of X-ray telescopes has grown to meet the demands of astronomy and astrophysics and, similarly, the depth and breadth of discovery in high energy Universe has driven the instrumentation to the state-of-the-art we have today. What will tomorrow bring? How can/will we continue this story in the next chapter?

Quasars and Active Galactic Nuclei with a large area, high resolution X-ray Telescope

Martin Elvis

Although quasars are the archetypal point sources, high angular resolution X-ray telescopes will make dramatic advances in this field. X-ray jets from blazars and radio galaxies, X-ray winds from AGNs, pairs of black holes in a single host, low luminosity nuclei and high resolution grating spectroscopy are all areas that will be transformed by higher angular resolution X-ray imaging with sufficient area.

Astronomical X-Ray Optics in the Czech Republic: Past, Present, Future

René Hudec, Pína L., Inneman A., ová V., Švéda L., Skulinová M.

The design and development of the space X-ray telescopes started in former Czechoslovakia in 1969 with the first X-ray telescope flown in 1979. These efforts were part of the former INTERCOSMOS space program, an East European and Soviet equivalent to ESA. 8 space X-ray telescopes were flown on 4 spacecrafts and space probes, including the large X-ray telescope on Soviet Salyut 7 orbital station in 1981. Almost all INTERKOSMOS and soviet spacecrafts with X-ray telescopes onboard used optics of Czech production. We describe shortly the motivation, the history, as well as the performed experiments as well as the technologies designed and developed. After the velvet revolution in 1989, the

development of astronomical X-ray optics continued in new conditions, with emphasis on design, developments and tests of various innovative technologies.

Lightweight and High Angular Resolution X-Ray Optics for the International X-ray Observatory

William Zhang

The International X-ray Observatory (IXO) mission requires a lightweight and high throughput spectroscopic telescope. The fabrication, alignment, and integration of this mirror assembly require breakthroughs in many areas. In this paper we report on our recent progress in all these areas, including mirror fabrication, coating, metrology, alignment, mechanical characteristics, and their integration into mirror modules. In particular, we will also outline our plan for the next few of years, showing approaches that will progress toward reaching the 5" HPD requirement.

New Technologies for Future Space X-Ray Telescopes

René Hudec, Pína L., Inneman A., Semencová V., Švéda L., Skulinová M.

Future large X-ray astronomical telescopes considered by ESA and NASA require development of fully innovative technologies able to provide very high accuracy at low weight and still reasonable cost. This requires development of novel light and precise substrates. We refer of development and tests of such technologies, including precise thermal glass forming and X-ray optics based on shaped Si wafers.

Lobster Eye Imaging Properties

Libor Švéda, Tichý V., Marsik J., Jakubek J., Semencová V., Hudec R., Pína L., Hromčík M.

Lobster eye optics, as a wide field of view imaging system, is perfectly suited for x-ray astronomy but can be useful also in the lab. We discuss the mirror design consequences on the resulting imaging properties of the system. Corrections of various image distortions and imperfections, either geometric, spectral or temporal in case of scanning observations have to be applied in order to get a valuable instrument. Some of the imperfections are demonstrated on the laboratory experiments. Further, several image processing methods are discussed and its strengths and weaknesses are shown.

Simbol-X: A formation flight mission with an unprecedented imaging capability in the 0.5-80 keV energy band based on Ni electroformed optics

Giovanni Pareschi, Philippe Ferrando, Gianpiero Tagliaferri, Jean-Michel Le Duigou, Philippe Laurent, Giuseppe Malaguti, Rodolphe Clédassou, Mauro Piermaria, Olivier La Marle, Fabrizio Fiore, Paolo Giommi

The discovery of X-ray emission from cosmic sources in the 1960s has opened a new powerful observing window on the Universe. In fact, the exploration of the X-ray sky during the 70s-90s has established X-ray astronomy as a fundamental field of astrophysics. Today, the emission from astrophysical sources is by large best known at energies below 10 keV. The main reason for this situation is purely technical since grazing incidence reflection has so far been limited to the soft X-ray band. Above 10 keV all the observations have been obtained with collimated detectors or coded mask instruments. To make a leap step forward in X-ray astronomy above 10 keV it is necessary to extend the principle of focusing X ray optics to higher energies, up to 80 keV and beyond. To this end, ASI and CNES are presently studying the implementation of a X-ray mission called Simbol-X. Taking advantage of emerging technology in mirror manufacturing and spacecraft formation flying, Simbol-X will push grazing incidence imaging up to ~80 keV and beyond, providing a strong improvement both in sensitivity and angular resolution compared to all instruments that have operated so far above 10 keV. This technological breakthrough will open a new high-energy window in astrophysics and cosmology. Here we will address the problematic of the development for such a distributed and deformable instrument. We will focus on the main performances of the telescope, like angular resolution, sensitivity and source localization. We will also describe the specificity of the calibration aspects of the payload distributed over two satellites and therefore in a not „frozen“ configuration.

New Developments for Electroformed Nickel Optics

Brian Ramsey, Darell Engelhaupt, Mikhail Gubarev, Steve O'Dell, Chet Speegle, Martin Weisskopf

Electroformed-nickel replicated (ENR) optics have found widespread use in x-ray astronomy. The limitation to their performance is typically due to axial figure errors imparted by the fabrication process, or introduced during mounting. We present new developments aimed at significantly improving the quality of ENR optics.

Galvanoplastic replication

Veronika Semencová, Rene Hudec, Adolf Inneman, Ladislav Pina

The galvanoplastic replication technology will be briefly introduced and discussed, with recent improvements. The replication can be used both for X-ray mirrors as well as for advanced smart focal planes.

Active X-ray optics

René Hudec, Martin Hromčík

The future large X-ray astronomy missions require fine angular resolution of 5 arcsec or better (IXO), and some even better than 1 arcsec (Generation X). Analogously, also some laboratory applications of imaging X-ray optics require sub-arcsec accuracy. These goals are hardly to achieve with classical X-ray optic arrangements. A solution is offered by the active X-ray optics where the superfine accuracy is achieved by the computer control and fine tuning of optical surfaces. Principles and various possible approaches in this direction will be presented and discussed. We will also present preliminary results achieved in development of suitable substrates as well as in computer surface control.

Control systems for adaptive X-ray optics

Martin Hromčík

This presentation is focused on the challenges related to the design of control systems for adaptive optics applications and their implementation. Specific issues related to the X-ray astronomy are mentioned. Main part of the talk is devoted to principal problems such as development of control laws, architecture of the controller, availability of computational algorithms, etc. Technological issues (suitable HW platforms, efficient implementation etc.) are also addressed in brief.

Generation-X telescope: measurement of on-orbit adjustment data

Dan Schwartz

Advances in lead silicate glass microchannel plate optics

George Fraser

Kirkpatrick-Baez Silicon Stacks for IXO or similar applications

Richard Willingale, Frank Spaan

A method of constructing a large aperture grazing incidence X-ray telescope utilising the Kirkpatrick-Baez geometry is described. Two crossed stacks of flat, wedged silicon plates comprise a single optical unit which provides focusing to a limit set by the plate separation within the stacks. If high precision silicon wafers are used and the focal length is large an angular resolution of a few arc second will be achievable. A tessellation of a large number of nearly identical stacks over a spherical aperture plane can provide a very large collecting area suitable for the IXO mission or similar X-ray astronomy applications. As a refinement an angular resolution at the limit imposed by the Kirkpatrick-Baez geometry could be met if the plates were very slightly curved to the correct parabolic profile along the axial direction.

Advanced Si wafers for X-ray telescopes

J. Šik, M. Lorenc

Future X-ray telescopes require precise and light-weight X-ray optics. Novel approaches are employed to find suitable substrates for mirrors, i.e., to achieve required geometries with the fine surface micro-roughness. Some proposed solutions are based on commercially available silicon wafers manufactured for semiconductor industry.

Relatively light and circular shaped wafers are commercially produced in diameters of 100 - 300 mm with the thickness of 380 - 780 μm . During the manufacturing process, wafer is lapped or ground to obtain parallel surfaces with thickness homogeneity better than 1 μm and finally polished to mirror-like surface with very low micro-roughness of 0.1 - 0.2 nm. To achieve these parameters, the production of Si wafers needs to be optimized.

Wide-Field Lobster-Eye X-Ray Telescopes & MFO Optics

R. Hudec, L. Pína, A. Inneman, V. Semencová, M. Skulinová, V. Tichý, M. Hromčík

The dense monitoring of X-ray sky with high sensitivity is an important task in X-ray astrophysics. We refer on wide-field X-ray optics of Lobster Eye type based on Multi Foil Optics (MFO), as well as on laboratory samples developed and tested.

Development of advanced grazing incidence optics at the Smithsonian Astrophysical Observatory

Paul Reid

For X-ray astronomy, 0.1 arc-second imaging resolution will result in a significant advance in our understanding of the Universe. Similarly, the advent of low cost high performance X-ray mirrors will also increase the likelihood of more X-ray telescopes being funded and built. We discuss the development plans of two different types of adjustable grazing incidence optics: one being a tenth arc-second resolution bimorph mirror approach also suitable for extremely large collecting areas, and the second being a few arc-second radially adjustable mirror approach more suitable for modest sized telescopes. Bimorph mirrors will be developed using thin (0.1 - 0.4 mm) thermally formed glass or electroplated metal mirror segments with thin film piezo-electric actuators deposited directly on the mirror back surface. Mirror figure will be adjusted on-orbit. Radially adjustable mirrors will employ discreet radially electrostrictive actuators for mirror alignment and low spatial error frequency figure correction during assembly and alignment. In this paper we report on. In this paper we describe mirror design and our development plans for both mirror concepts.

Changes in glass irradiated with an electron beam

Ondrej Gedeon, Karel Jurek, Ivo Drbohlav, Josef Zemek

Silicate glasses of various composition, mostly model binary and ternary ones, were irradiated with medium- (1-50 keV) and high-energy (2.5 MeV) electrons. Changes both in bulk and on the surface of the irradiated samples are described in terms of composition, surface roughness, and volume dilatation. While small electron dose causes volume contraction, large dose can cause volume expansion, namely in dependence on glass composition. Alkali glasses can reveal escape of alkali ions from the surface, again in dependence on the dose and initial composition of glass. Increase of roughness with electron dose is also observed.

Development of hot plastic deformation of silicon for X-ray pore optics

Yuichiro Ezoe, Takayuki Shirata, Takaya Ohashi, Manabu Ishida, Kazuhisa Mitsuda, Kozo Fujiwara, Kohei Morishita, Kazuo Nakajima

Reflection Grating Optics

Webster Cash

We review the need for high resolution spectroscopy on future x-ray astronomy missions. We compare the approaches and conclude that off-plane reflection gratings remain the most capable and robust approach. In particular, we show how off-plane gratings can be used in the International X-ray Observatory without the need for high mass arrays of optics.

Slumped glass option for making the IXO mirrors

Mauro Ghigo, R. Canestrari, L. Proserpio, E. Dell'Orto, S. Basso, O. Citterio, G. Pareschi

The IXO telescope (International X-ray Observatory) is a joint mission of ESA/NASA/JAXA agencies mainly for soft X-ray imaging and spectroscopy. With the present configuration, IXO has about 3.5 m² @ 1 keV of collecting area with an angular resolution requirement of 5 arcsec. This large collecting area could be obtained with a mirror assembly composed of a large number of high quality segments each being able to deliver the angular resolution requested by the mission or better. The IXO telescope will fit in the fairing of an ATLAS V 551 launcher and hence its diameter is approximately 3.3 m. Due to the large size of the optics it is impossible to create closed shells like those used for XMM or Chandra and hence it will be necessary to assemble a large number of segments (for example of ~0.6 m x ~0.3 m size) to recreate the mirror shells. These segments will form a module, an optical sub-unit of the telescope. The modules will be assembled to form the whole mirror system. As for all the space missions, the limits imposed on the payload mass budget by the launcher is the main driver that force the use of very lightweight optics and this request is of course very challenging. Starting from a previous work made in INAF-OAB on the thermal shaping of thin glass optics, we suggest a possible approach for the realization of large size and lightweight X-ray mirrors. The slumping process foresees

the use of a negative Wolter I shape mould having a good optical figure (about 2 arcsec) and a very good surface finishing quality (microroughness below 5 Å). On the mould is placed an initially flat very thin glass sheet (for example 0.3 – 0.4 mm thick) and applying a suitable thermal cycle the glass is conformed to the mould shape. Once tested for acceptance the glass sheet it is then integrated into a module by means of a robotic arm having a feedback system to confirm the correct alignment. Due to high angular resolution requirement of the telescope, the slumping process needs very good moulds, both in figure and microroughness. One attractive possibility is to manufacture them in Silicon Carbide, for its high thermal conductivity, low CTE and good surface finishing quality that can be reached. A problem using this material is the sticking of the glass on the mould. It is hence mandatory to solve this issue in a proper way. Here, we report some results on using coating layers as anti-sticking for the glass sheets.

Aspects of Glass Foils Thermal Forming for X-ray Telescopes Mirrors

Martin Míka, Martina Landová, Veronika Semencová, René Hudec, Adolf Inneman, Ladislav Pína, Michaela Skulinová, Libor Švéda, Vlastimil Brožek, Jan Šik

We have studied the precise thermal forming of glass foils with the aim to develop a low-cost technology suitable for the mass-producing of thin X-ray optics shells meeting the requirements of the future large X-ray telescopes. We used commercially available thin glass foils with an excellent microroughness of few 0.1 nm. Our special composite mandrels with surfaces avoiding the sticking of glass foils served as the support for the foils during the slumping process. In some experiments additional force was applied on the top surface of the samples. To optimize the process we varied both temperature and time of heat-treatment following our experiment design. We measured the shape and surface quality (the waviness and micro-roughness) of the micro-sheets employing the Tylor-Hobson mechanical profilometry, the optical interferometry (ZYGO), and the Atomic Force Microscopy (AFM) analysis. Knowing the response surfaces of the measured properties, we were able to determine the time-temperature area where we achieved the best surface quality with the micro-roughness below 0.3 nm. Within this area the shape of the foils was dependent on the soaking time and temperature; hence, we are able to modify the shape by controlling these two parameters keeping the high surface quality. This way we can fabricate foils of various shapes using just one mandrel. We suppose that this approach can substantially reduce the number of expensive mandrels needed for the production of shells with various shapes. We expect that besides lowering costs this technology can also significantly speed up the manufacture of X-ray telescopes mirrors.

POSTERS

Comparison of relativistic iron line models

Jiří Svoboda, Michal Dovčiak, René W. Goosmann, Vladimír Karas

The analysis of the broad iron line profile in the X-ray spectra of active galactic nuclei and black hole X-ray binaries allows us to constrain the spin parameter of the black hole. We compare the constraints on the spin value for two X-ray sources, MCG-6-30-15 and GX 339-4, with a broad iron line using present relativistic line models in XSPEC – LAOR and KYRLINE. The LAOR model has the spin value set to the extremal value $a = 0.9982$, while the KYRLINE model enables direct fitting of the spin parameter. The spin value is constrained mainly by the lower boundary of the broad line, which depends on the inner boundary of the disk emission where the gravitational redshift is maximal. The position of the inner disk boundary is usually identified with the marginally stable orbit which is related to the spin value. In this way the LAOR model can be used to estimate the spin value. We investigate the consistency of the LAOR and KYRLINE models. We find that the LAOR model tends to overestimate the spin value. However, the discrepancies between results of both models are within the general uncertainties when applied on the current data.

Hot-spot model for accretion disc variability as random process

Tomáš Pecháček, V. Karas, B. Czerny

Radiation from accreting black holes varies on different time-scales. In X-rays, the observed light-curve, is a complicated noisy curve that can be represented by a broad-band power spectrum. The 'hot spots' on the accretion disc have been identified a possible contributor to this variability. These spots are supposed to occur on the surface of an accretion disc following its irradiation by coronal flares. Various schemes have been proposed in which spots are mutually interconnected in some way. We discuss the statistical properties of model light-curves, constructed as a sum of contributions from many point-like sources that are orbiting above an underlying accretion disc. Particularly, we examine the power spectral profiles generated by different kinds of avalanching mechanisms, using the framework of the theory of point processes.

Robotic optical telescopes as ground-based support for X-ray telescopes

Matus Kocka, F. Munz, R. Hudec, J. Štrobl, M. Nekola, C. Polášek, P. Kubánek, M. Jelínek, V. Šimon

In this paper we refer about using robotic or autonome telescopes, such as new D50 and BART telescopes in the Astronomical Institute in Ondřejov, to support the INTEGRAL mission and in the future Gaia mission. These telescopes usually observe CVs, AGNs and error circles of GRBs and are also capable to point at any interesting sources in very short time

X-ray spectra and polarization from accreting black holes – Signatures of a rotating black hole

Vladimír Karas, Michal Dovčiak, René W. Goosmann, Fabio Muleri, Giorgio Matt

Thermal emission from the accretion disc around the black hole can be polarized on its way through the atmosphere above the accretion disc. We model this effect by assuming Kerr metric for the black hole, a standard thin disc for the accretion flow and Thomson scattering in the atmosphere. We compute the expected polarization degree and the angle as they can be measured for different inclinations of the observer, optical thickness of the atmosphere and different values of the black hole spin. All relativistic effects near a compact centre are taken into account. We also assess the perspectives for the next generation of X-ray polarimeters. The expected sensitivity of the detectors onboard the planned POLARIX and IXO missions is considered. The flux level of the microquasar GRS~1915+105 in the thermal state is used in the computations. We find that the energy dependence of the polarization degree and angle will discriminate between cases with different spin of the black hole. This poster summarizes our recent results reported in a paper published in Monthly Notices of the Royal Astronomical Society (<http://arxiv.org/abs/0809.0418>).

Experimental and ongoing studies on segmented X-Ray optics made of slumped glass

Monika Vongehr

Experimental and ongoing studies on segmented X-Ray optics made of slumped glass in MPE

Thermal Forming of Glass Foils for X-ray Space Telescopes

Martina Landová, Martin Míka, Veronika Semencová, Roman Kačerovský, René Hudec, Adolf Inneman, Libor Švéda, Ladislav Pína, Michaela Skulinová, Jan Šik

The thermally formed thin glass foil is considered to belong to most promising technologies for future large space X-ray telescopes. Promising results have been achieved, with peak to valley deviations of final profiles from the ideal ones being of order of 1 micron in best cases. We determine the physical properties that elucidate the formation process and that is crucial to improve surface quality. We discuss the sources of figure errors and we measure relations between time of forming and surface characteristics.

Alternative materials in view of new light weight X-ray optics

Michaela Skulinová, R. Hudec, J. Šik, M. Lorenz, L. Pína, V. Semencová

The ESA's invitation to participate in the innovative technology developments for the new space mission represents the natural continuation of the efforts of the Czech team in development of innovative X-ray telescopes, focusing on particular demands and requirements of a concrete project, with emphasis on fully new and light-weight technologies. In this paper we focus on studying of other

alternative materials such as SiC or glassy carbon, which could be considered as suitable materials for the producing of precise light weight X-ray optics due to their physical and chemical properties and in so far successfully compete with more common materials as glass or Si.