
High-throughput X-ray Astronomy
in the eXTP era
eXTP开启高产出X射线天文新纪元
6-8 February 2017 - Rome, Italy
Abstract Booklet

Abstracts booklet content

1 Agenda of the Conference

Monday 6 February

The eXTP mission

Chair: Shuang-Nan Zhang
08:30 – 09:30 Registration
09:30 – 09:40 Welcome address – Marco Feroci (INAF-IAPS, Italy)
09:40 – 10:00 Address by the ASI President – Roberto Battiston (ASI, Italy)
10:00 – 10:15 Address by CNSA – Zhao Jian (CNSA, China)
10:15 – 10:45 ESA Cooperation Program with China (I) – A. Parmar (ESA, Netherlands)

10:45 – 11.15 Coffee Break

Chair: S. Zane
11:15 – 11:45 High–throughput X–ray astronomy (I) – Luigi Stella (INAF-OAR, Italy)
11:45 – 12:15 The eXTP Mission (I) – Shuang-Nan Zhang (IHEP)/Marco Feroci (INAF-IAPS, Italy)
12:15 – 12:35 Preliminary design of the eXTP satellite (S) – Hong Bin (CAST, China)
12:35 – 12:50 Current design of the eXTP payload (S) – Xu Yupeng (IHEP, China)
12:50 – 13:10 The eXTP science performance (S) – Fangjun Lu (IHEP, China)

13:10 – 14:25 Lunch Break

Dense Matter

Chair: D. Barret
14:25 – 14:55 Dense Matter investigations with eXTP (I) – Anna Watts (UvA, Netherlands)
14:55 – 15:25 Constraining the NS EoS with QPOs (I) – Wenfei Yu (SAO, China)
15:25 – 15:55 NS radii and masses constraints from bursts and polarization (I) – Juri Poutanen (Univ. of Turku, Finland)
15:55 – 16:10 Using mHz QPOs to put constraints on NS size and EOS with eXTP – Holger Stiele (National Tsing Hua Univ., Taiwan)
16:10 – 16:25 Matter at extreme densities: models and open problems – Ignazio Bombaci (Pisa Univ., Italy)

16:25 – 16:55 Coffee Break

Observatory Science I

Chair: S. Brandt
16:55 – 17:25 Observatory science with eXTP (I) – Jean in 't Zand (SRON, Netherlands)
17:25 – 17:40 BH accretion and wind (S) – Yuan Feng (SAO, China)
17:40 – 17:55 Disk/corona modelling in the eXTP era (S) – Liu Bifang (NAO, China)
17:55 – 18:10 eXTP observation of supernova remnants and pulsar wind nebulae (S) – Cheng Yang (Nanjing Univ., China)
18:10 – 18:25 Observing SS 433 with eXTP – Herman Marshall

Tuedsay 7 February

Accretion in Strong Field Gravity

Chair: G. Matt
09:00 – 09:30 Fe–line diagnostics in accreting BHs (I) – Alessandra De Rosa (INAF-IAPS, Italy)
09:30 – 09:50 eXTP continuum fitting in XRBs (S) – Gou Lijun (NAO, China)
09:50 – 10:05 Comparing origins of low-frequency QPOs with spectral-timing – Abigail Stevens (UVA, Netherlands)
10:05 – 10:20 Testing the relativistic precession model using low frequency and kHz QPOs in NS LMXBs with known spin – Marieke van Doesburgh (UVA, Netherlands)
10:20 – 10:35 Geodesic models of Quasi Periodic Oscillations as probe of strong gravity effects – Andrea Maselli (IAAT, Germany)
10:35 – 10:50 Winds and high energy flares in GRO J1655-40 – Emrah Kalemci (Sabanci Univ., Turkey)
10:50 – 11:05 Quantitative tests of propagating mass accretion rate fluctuations: achievements and challenges – Stefano Rapisarda (API, Netherlands)

11:05 – 11.35 Coffee Break

Chair: D. Chakrabarty
11:35 – 12:05 Reverberation mapping (I) – Phil Uttley (UvA, Netherlands)
12:05 – 12:25 Spectral–polarimetry of QPOs (S) – Adam Ingram (UVA, Netherlands)
12:25 – 12:40 Time average polarimetry (S) – Yuan Yefei (USTC, China)
12:40 – 12:55 The effects of spectral hardness changes on reverberation lags – Guglielmo Mastroserio (UVA, Netherlands)

12:55 – 14:30 Lunch Break

Strong Magnetism

Chair: S. Zhang
14:30 – 15:00 eXTP polarimetry: a new science window (I) – Hua Feng (Tsinghua Univ., China)
15:00 – 15:15 The X-ray polarization of reprocessed emission in BH systems – Rene W. Goosman (Strasbourg Obs., France)
15:15 – 15:30 Echoes of the past outbursts of Sgr A* to be revealed with X-ray polarimetry – Frederic Marin (Strasbourg Obs., France)
15:30 – 16:00 X–ray polarimetry and fundamental physics (I) – Jeremy Heyl (UBC, Canada)
16:00 – 16:15 Polarized X-ray emission from compact objects with eXTP – Ilaria Caiazzo (UBC, Canada)
16:15 – 16:30 Probing Galactic Center Cosmic-rays with X-ray Polarimetry – Shuo Zhang (MIT, USA)

16:30 – 17:00 Coffee Break

Compact Objects

Chair: S. Bhattacharyya
17:00 – 17:15 QPO simulations with eXTP (S) – Ge Mingyu (IHEP, China)
17:15 – 17:30 Accretion and rotation power in transitional millisecond pulsars – Alessandro Papitto (INAF-OAR, Italy)
17:30 – 17:45 The ignition site of type-I X-ray bursts on the surface of NSs – Guobao Zhang (NYU, USA)
17:45 – 18:00 Discovery of a slow and soft QPO in the accreting millisecond pulsar IGR J00291+5934 – Carlo Ferrigno (ISDC, Switzerland)
18:00 – 18:15 Quasi-periodic modulation of accreting millisecond X-ray pulsars – Peter Bult (GSFC, USA)

Wednesday 8 February

Current and Future Missions

Chair: J. W. den Herder
09:00 – 09:15 ASTROSAT (S) – Sudip Bhattacharyya (TIFR, India)
09:15 – 09:30 Athena status and a focus on its timing capabilities (S) – Didier Barret (IRAP, France)
09:30 – 09:45 NiCER (S) – Paul Ray (NRL, USA)
09:45 – 10:00 STROBE–X (S) – Paul Ray (NRL, USA)
10:00 – 10:15 IXPE and XIPE (S) – Paolo Soffitta (INAF-IASF, Italy)
10:15 – 10:30 SVOM (S) – S. Schanne (CEA, France)

10:30 – 11:00 Coffee Break

Chair: A. Vacchi
11:00 – 11:15 HXMT and POLAR (S) – Shuang–Nan Zhang (IHEP, China)
11:15 – 11:30 Spectrum–X–Gamma (S) – Mikhail Pavlinski (IKI, Russia)
11:30 – 11:45 MVN, G400, and other Russian projects in X-ray Astronomy – Alexander Lutovinov (IKI, Russia)
11:45 – 12:00 THESEUS – Lorenzo Amati (INAF-IASF Bologna, Italy)
12:00 – 12:15 A sub-keV X-ray polarimeter - Herman Marshall (MIT - USA)
12:15 – 12:30 Development of X-ray imaging telescope optics for eXTP mission – Zhanshan Wang (Tongji Univ., China)

Multi–messenger & Time–Domain Astronomy

12:30 – 13:00 Synergies between eXTP and the GW observatories (I) – Renxin Xu (Peking Univ.)
13:00 – 13:15 TeV (S) – Andrea Santangelo (IAAT, Germany)
13:15 – 13:30 eXTP and Optical Polarimetry in the ELT Era – Andrew Shearer (National Univ. of Ireland, Ireland)

13:30 – 14:30 Lunch Break

Strongly Magnetized Sources & Gamma-ray Bursts

Chair: V. Karas
14:30 – 15:00 Polarization in strongly magnetized sources (I) – Andrei Beloborodov (Columbia Univ., USA)
15:00 – 15:15 GRB observations with eXTP (S) – Lorenzo Amati (INAF-IASF Bologna, Italy)
15:15 – 15:30 GRB afterglows with eXTP (S) – Wu Xuefeng / Mixiang Lan (PMO, China)
15:30 – 15:45 eXTP contribution to the study of rotation-powered pulsars – Roberto Mignani (INAF-IASF Milano, Italy)
15:45 – 16:00 Supergiant Fast X-ray Transients with eXTP – Patrizia Romano (INAF-OA Brera, Italy)

16:00 – 16:30 Coffee Break

Magnetars

Chair: M. Hernanz
16:30 – 17:00 Magnetars (I) – Gianluca Israel (INAF-OAR, Italy)
17:00 – 17:15 The outbursts of magnetars (S) – Lin Lin (Beijing Normal Univ., China)
17:15 – 17:30 Magnetars in binaries (S) – Wei Wang (NAOC, China)
17:30 – 17:45 Polarized thermal emission from strongly magnetized NSs – Denis Gonzalez–Caniulef (UCL/MSSL, UK)

17:45 – 18:00 Concluding Remarks – Andrea Santangelo (IAAT, Germany)
End of the Workshop

2 Invited talks

2.1 High–throughput X–ray astronomy (Luigi Stella)

High-throughput X-ray observations of compact objects provide direct access to: i. the physics of matter accretion in the very strong gravitational fields of black holes and neutron stars; ii. the equation of state of ultra-dense matter; iii. fundamental processes in extremely high magnetic fields. The instrumentation of eXTP, with its unique characteristics in terms of effective area, spectral resolution and polarimetric capability, is ideally suited to make a major leap in these areas of research. This presentation summarises key diagnostics to be exploited and surveys some major goals of the mission.

2.2 The eXTP Mission (Marco Feroci/ Shuang-Nan Zhang)

Presentation of the overall eXTP mission concept, including a discussion on the European involvement.

2.3 Dense matter investigations with eXTP (Anna Watts)

Neutron stars offer a unique environment in which to develop and test theories of the strong force. Densities in neutron star cores can reach up to ten times the density of a normal atomic nucleus, and the stabilising effect of gravitational confinement permits long-timescale weak interactions. This generates matter that is neutron-rich, and opens up the possibility of stable states of strange matter, something that can only exist in neutron stars. Strong force physics is encoded in the Equation of State (EOS), the pressure-density relation, which links to macroscopic observables such as mass M and radius R via the stellar structure equations. By measuring and inverting the M-R relation we can recover the EOS and diagnose the underlying dense matter physics. One very promising technique for simultaneous measurement of M and R exploits hostpots that form on the neutron star surface, for example during a thermonuclear explosion. As the star rotates, the hotspot gives rise to a pulsation, and relativistic effects then encode information about M and R into the pulse profile. I will present our current understanding of the hotspot generation mechanism on bursting neutron stars: ignition conditions, flame spread, and the magneto-hydrodynamics of the star's ocean all play a role. I will also review our progress towards establishing burst oscillations as a tool par excellence for measuring M and R in the context of the eXTP mission.

2.4 Constraining the NS EoS with QPOs (Wenfei Yu)

Diverse QPOs in NS LMXBs in the frequency range of between mHz and kHz NS are important timing signals observable with a future timing mission such as the eXTP. Their characteristic frequencies, spectral contents as well as their coherence and photon energy dependent time lags bring plenty information of the neutron stars in those LMXBs and their immediate environment in the strong gravity regime. Here I briefly review the progress of using these QPOs , especially the kHz QPOs and the mHz QPOs in NS LMXBs, to put constraints on NS EOS, and address the potential and expectation of the eXTP mission with intensive observations of these QPOs.

2.5 NS radii and masses constraints from bursts and polarization (Juri Poutanen)

Constraints on the neutron star equation of state can be obtained by measuring their masses and radii. The cooling tail method applied to the thermal emission during thermonuclear X-ray bursts allows to obtain such constraints. In case of accreting millisecond pulsars, these constraints can be improved by modelling their pulse profiles. Polarimetric observations further improve the situation by breaking degeneracy between the inclinations of the observer and the magnetic field. I will show that 5% errors on masses and radii can realistically be achieved.

2.6 eXTP Observatory Science (Jean in 't Zand)

Although tuned to strong gravity, dense matter and strong magnetism, eXTP has capabilities in many more areas of interest within the astrophysical community. These often touch on the scientific questions posed in ESA's Cosmic Vision. This presentation gives a brief overview of these areas, mostly drawing from the LOFT White Papers.

2.7 Fe–line diagnostics in accreting BHs (Alessandra De Rosa)

The very broad Fe K profiles observed in both AGN and XRBs provide a sensitive probe of the circumstances in the strong field region, and estimates of black hole spin. Some current stellar as well as super-massive black hole spin estimates based on measuring time-averaged line profiles suggest near-maximal spins, but there are complications related to spectral complexity and pile-up effects (in XRB), so that significant discrepancies occur with respect to other techniques. In this talk I will review the spectral and time resolved spectral techniques that can be applied to X-ray data, in order to infer the behavior of the matter into SFG regime. Detailed simulations show that the eXTP spectral timing capability will allow us to explore with a great accuracy the physical phenomena in the region close to the black hole.

2.8 Reverberation Mapping (Phil Uttley)

X-ray reverberation mapping enables us to reconstruct the geometry of the accretion flow and emitting regions close to compact objects, and so offers completely new insights into the behavior of matter in strong-field gravity. I will give a brief introduction into the current state-of-the-art of X-ray reverberation studies, and a look ahead to what will be possible with missions with much larger collecting areas and also polarimetric capability, as offered by eXTP.

2.9 eXTP polarimetry: a new science window (Hua Feng)

Large area X-ray polarimetry will be one of the unique capabilities of eXTP. However, eXTP will not be the first or a dedicated X-ray polarimeter. Besides that, it should be significantly more powerful than IXPE in terms of X-ray polarimetry, the targets for eXTP polarimetry should be well in line with those for timing and spectroscopy. I will summarize the most interesting science problems that can be addressed with X-ray polarimetry, the current design and performance of the detector, and hope to initiate the discussion about how to optimize the instrument design.

2.10 X–ray polarimetry and fundamental physics (Jeremy Heyl)

Compact objects provide a unique environment to probe physics at the extreme from gravity to nuclear physics and plasma physics. I am going to focus on how strongly neutron stars (magnetars) can help us probe quantum electrodynamics in a regime that hasn't yet been tested. I will outline how to perform calculations in non-perturbative QED and how observations of the polarization of x-rays from compact objects probes the non-linearity of the QED vacuum.

2.11 Synergies between eXTP and the GW observatories (Renxin Xu)

The state of dense baryonic matter compressed during supernova is not yet well understood because of the non-perturbative nature of the fundamental strong interaction, but it is popularly speculated that those compact stars are composed of nucleons (this kind matter should be actually neutron rich because of the weak interaction, and we thus usually call them as neutron stars). However, it is already proposed that these compact stars are composed of strangeons. Strangeon is an abbreviation of strange nucleon, in which the constituent quarks are of three flavors (up, down, and strange) rather than of two for nucleons. Due to its high sensitivity, wide spectroscopy, as well as polarimetric ability, we are expecting to differentiate neutron stars and strangeon stars in the eXTP era.

2.12 Polarization in strongly magnetized sources (Andrei Beloborodov)

The role of strong magnetic fields for producing radiation in compact objects will be reviewed, and the expected X-ray polarization will be discussed. I will also comment on the expected X-ray polarization of the prompt emission in cosmological gamma-ray bursts.

2.13 Magnetars (Gianluca Israel)

In March 1979 rapid coherent X-ray pulsations were discovered during an intense flare from SGR0506-66, the prototype of the magnetar class. Since then, many advances have been achieved in the study of this class of high energy emitting isolated neutron stars, thought to shine in the X-rays due to the decay of the strongest magnetic fields present in the Universe (> 10^14 Gauss). The results obtained through the study of the transient phenomena displayed by some of them over more than 10 orders of magnitudes of time scale variability (from fraction of milli-seconds up to years) will be briefly outlined, with particular emphasis on a number of results. Among others are: the discovery of rapid QPOs in the giant flares of SGR1806-20 and SGR1900+14, the study of intermediate flares, and the detection of magnetars with very unusual physical parameters (standing up with respect to the bulk of known objects). Finally, a number of possible eXTP studies on these extreme objects will be presented.

3 Solicited talks

3.1 Preliminary design of the eXTP satellite (Hong Bin)

The enhanced X-ray Timing and Polarimetry mission (eXTP), is a science mission designed to study the state of matter under extreme conditions of density, gravity, and magnetism. The primary goal of the eXTP satellite study is to meet the requirement of science. So far we have achieved the basic parameters, solved the key technologies such as integrated structure, low temperature control. This report is mainly introduced the preliminary design of the eXTP satellite.

3.2 Current design of the eXTP payload (Xu Yupeng)

The eXTP payload consists of four instruments: the Spectroscopic Focusing Array (SFA) - a set of 11 X-ray optics and pixelated silicon drift detectors (SDDs) for a total effective area of ~0.9m2 and 0.6m2 at 2keV and 6keV respectively, and energy resolution better than 180eV(@6keV); the Polarimetry Focusing Array (PFA) - a set of 2 X-ray optics and imaging gas pixel photoelectric detectors, with total effective area of 200cm2; the Large Area Detector(LAD) - a deployable set of 640 SDDs, for a total effective area of ~3.4m2, between 6 and 10 keV, and a collimated 1°field of view; the Wide Field Monitor – a set of 3 coded mask wide field units, with a total field of view ~1π and location accuracy of 1 arcmin. The current design and status of the instruments will be presented in this talk.

3.3 The eXTP science performance (Fangjun Lu)

In this talk, I will give the performance of the two main instruments on board eXTP, the Spectroscopic Focusing Array (SFA) and the Large Area Detector (LAD). Study of the performance is based on simulations of different background components and the response matrices of these instruments. The estimated continuum sensitivity of SFA at 6 keV is about 1 micro-Crab (5sigma, 1E5 s) and that for LAD is 0.03mCrab.

3.4 Black hole accretion and outflow (Feng Yuan)

In recent years, mainly attributed to the rapid development of numerical simulations, many progresses have been made. These include the wind from hot accretion flow, jet formation, and super-Eddington accretion. I will review these developments in my talk.

3.5 Disk/corona modelling in the eXTP era (Liu Bifang)

I'll introduce our disk corona interaction model in stellar-mass and supermassive black holes. By combining its powerful X-ray timing and spectroscopy approach of eXTP, we would be able to investigate the geometry of accretion flow close to the black holes.

3.6 eXTP observation of supernova remnants and pulsar wind nebulae (Yang CHEN)

eXTP will be powerful in observing the polarized X-ray synchrotron emission from shell-type supernova remnants and pulsar wind nebulae. The observation will benefit to elucidate some basic properties in the related physics: effective injection with respect to the magnetic field, acceleration at the reverse shock, the non-thermal component blended by thermal X-rays, B-field configuration in PWNe, etc. We will give a forecast of the effect of eXTP observation of shell-like remnants and PWNe with preliminary simulation.

3.7 eXTP continuum fitting in XRBs (Lijun Gou)

Two methods, continuum-fitting and iron-line profile-fitting, are widely used for the BH spin measurement, and I will briefly review the continuum fitting method in the eXTP era.

3.8 Spectral–polarimetry of QPOs (Adam Ingram)

Accreting stellar-mass black holes routinely show low frequency quasi-periodic oscillations (QPOs) in their X-ray flux, with a period that slowly drifts from ~10s to ~0.05s. I will talk about the evidence we currently have that these QPOs are driven by Lense-Thirring precession of the inner accretion flow. This is a relativistic effect whereby a massive spinning body twists up the surrounding space-time, causing a wobble in the orbital plane of nearby orbits. The precession model predicts a characteristic rocking of the iron line between red and blue shift as the receding and approaching sides of the disk are respectively illuminated. We recently measured this effect for the first time in H 1743-322 using XMM-Newton and NuSTAR. I will show how the high throughput of eXTP will revolutionize this young field of QPO phase-resolved spectroscopy. I will then talk about the quasi-periodic swings in X-ray polarization angle predicted by the precession model, and show how we can measure such swings with eXTP.

3.9 Time average polarimetry (Yuan Yefei)

When the stellar black hole accretion system is in the thermal state, the degree of polarization of X-ray photon from the disk is about a few percent, which is due to the dominant electron scattering in the inner region of the accretion disk. In addition, during the propagation of X-ray photons in the strong gravitational, the combination of the effects of relativistic beaming, gravitational lensing, frame dragging can lead to increase of their degree of polarization. We have investigated the degree of polarization of the emitted X-ray photons from the relativistic slim disks surrounding Kerr black holes. It is found that both the returning irradiation and the effect of the self-shadowing due to the thickness of the disk increase the degree of X-ray polarization significantly.

3.10 QPO simulations with eXTP (Mingyu Ge)

With the large effective area, eXTP has an excellent power for X-ray timing observation, especially for X-ray binaries, which will supply a great opportunity for exploring the nature of Quasi-periodic Oscillation

(QPO) in the eXTP era. With the energy response matrix of eXTP, the simulation is processed to show the ability of the measurement for the basic parameters of QPO, also including the evolution with time and energy.

3.11 ASTROSAT (Sudip Bhattacharyya)

Report on the status of the mission.

3.12 ATHENA status and a focus on its timing capabilities (Didier Barret)

Report on the status of the mission with a particular focus on the foreseen high timing capabilities.

3.13 NiCER (Paul Ray)

Report on the status of the mission.

3.14 STROBE–X (Paul Ray)

Report on the status of the project.

3.15 IXPE and XIPE (Paolo Soffitta)

Report on the status of the two missions.

3.16 SVOM (Stephane Schanne)

Report on the status of the mission.

3.17 HXMT and POLAR (Shuang–Nan Zhang)

Report on the status of the two missions.

3.18 Spectrum–X–Gamma (Mikhail Pavlinski)

Report on the status of the mission.

3.19 Russian projects in X-ray Astronomy (Alexander Lutovinov)

The talk would focus on projects in the Russian program – from MVN to G400.

3.20 THESEUS (Lorenzo Amati)

Report on the status of the project.

3.21 Synergies between eXTP and the TeV facilities (Andrea Santangelo)

Overview of the synergies expected between the eXTP mission and the available/future facilities for observations in the TeV energy domain.

3.22 GRB observations with eXTP (Lorenzo Amati)

The study of cosmic Gamma-Ray Bursts (GRB) is of high interest for several fields of modern astrophysics, cosmology and even fundamental physics. Moreover, they are a key target for multi-messenger (GW, neutrinos) astrophysics. However, despite the substantial progress occurred in the last 20 years thanks to huge observational and theoretical efforts, our comprehension of GRBs is still affected by several fundamental open issues which cannot be addressed by presently operating space-born facilities. I will show how the unique combination of wide and narrow field instruments, as well as the mostly unprecedented timing, spectroscopic and polarimetric capabilities, of the eXTP payload will allow to make a significant step forward towards the full understanding and exploitation of these extreme phenomena.

3.23 GRB afterglows with eXTP (Wu Xuefeng)

In our talk, we will review the general physical pictures of gamma-ray bursts (GRBs), talking about the different magnetic field configurations and polarization models for GRB central engine scenarios. We will mainly focus on probing the underlying physics of GRB X-ray flares and plateaus with eXTP, by presenting preliminary simulation results of polarization detections of X-ray flares and the theoretical polarization evolutions of X-ray plateaus, which may provide very important clues to GRB central engines.

3.24 The outbursts of magnetars (Lin Lin)

Bursts and outbursts are two main observational phenomena from magnetars. In this talk, I will summarize their properties and connections between them. I will also try to discuss the possibilities for magnetars in the eXTP era.

3.25 Magnetars in binaries (Wei Wang)

Magnetars in AXPs and SGRs are isolated magnetars. Recent X-ray observations detected some magnetar candidates in X-ray binaries, named as accreting magnetars. I will review the properties of the magnetar candidates in binaries, including super-slow pulsation X-ray pulsars and ultra-luminous X-ray pulsars. Finally, possible science studies of accreting magnetars using eXTP are briefly discussed.

4 Contributed talks

4.1 The eXTP contribution to the study of rotation-powered pulsars (Roberto Mignani)

The eXTP mission will enable astronomers to carry out a number of studies of rotation powered pulsars, which are difficult or impossible with current facilities. The LAD will enable to study X ray light curve profiles with an exquisite level of details, which will disclose important information on the X-ray emission geometry and geography in the neutron star magnetosphere and will enable one ti study, for the first time in the X-rays, erratic phenomena such as Giant Pulses, so far onl observed in radio and in the optical. X-ray polarimetry observations will be crucial to deliver information on the neutron star magnetic field and on the magnetic field structure within the pulsar wind nebulae. In this talk, I will outline perspectives for studies of rotation-powered pulsars with eXTP and discuss possible synergies with multi-wavelength facilities.

4.2 Geodesic models of QPOs as probe of strong gravity effects (Andrea Maselli)

In this talk I analyze the chances to detect strong gravity effects through quasi-periodic oscillations (QPOs) of rotating black holes. I derive the epicyclic frequencies of a slowly rotating black hole in quadratic gravity theories, finding that they differ from those computed in General Relativity. Then I compare various geodesic models used to interpret QPOs from low mass X-ray binaries, showing that the differences between the frequencies predicted by the theories of gravity considered, can be large enough to be observed.

4.3 Echoes of the past outbursts of Sgr A* to be revealed with X-ray polarimetry (Frederic Marin)

The detection of hard X-ray spectra and prominent iron K_alpha fluorescence features coincident with localized gas clouds in the Galactic Center is known for nearly twenty years now. A common hypothesis is to associate part of this diffuse emission with past outbursts of the central supermassive black hole Sgr A*, whose radiation is reprocessing onto the so-called reflection nebulae. Such theory implies a more turbulent history, i.e. an active phase, of Sgr A*, and since scattering leads to polarization, the re-emitted signal from the giant molecular clouds is expected to be polarized. This is the topic of our presentation, where we simulate the close (~100 pc) environment of Sgr A* according to the constraints established in synergy with infrared observations. Doing so, we predict the resulting X-ray polarization signal emerging from different reprocessing structures, and show how modern imaging polarimeters could revolutionize our understanding of the Galactic Center.

4.4 Discovery of a slow and soft QPO in the accreting millisecond pulsar IGR J00291+5934 (Carlo Ferrigno)

We will illustrate the peculiar X-ray variability displayed by the accreting millisecond X-ray pulsar IGR J00291+5934 in a 80 ks-long joint Nustar and XMM-Newton observation performed during the source outburst in 2015. The lightcurve of the source is characterized by a flaring-like behavior, with typical rise and decay timescales of ~120 s. The flares are accompanied by a remarkable spectral variability, with the X-ray emission being generally softer at the peak of the flares. A strong QPO is detected at ~8 mHz in the power spectrum of the source and clearly associated to its flaring-like behavior. This feature has the strongest power at soft X-rays (<3 keV). We carried out a dedicated hardness-ratio resolved spectral analysis and a QPO-phase resolved spectral analysis together with an in-depth study of the source timing properties to investigate the origin of this behavior. We discuss that it could be due either a disk-instability like the hearth-beat in the black-hole binary GRS 1915+105, or, less likely, to unstable nuclear burning on the neutron star surface, as observed in the burster 4U1636-536. This phenomenology could be ideally studied with the large throughput and wide energy coverage of the instruments on board eXTP.

4.5 The ignition site of type-I X-ray bursts on the surface of NSs (Guobao Zhang)

Type-I X-ray bursts are thermonuclear explosions occurring on the surface of accreting neutron stars. These events are powerful probes of the extreme environment in which they are produced. We studied the evolution of the pre-burst emission, the shape of the rising and decaying phases of the burst light curve and the spectral and timing properties during the burst in several systems. Our results indicate that all the above properties are related to the burst ignition site on the neutron-star surface. With eXTP we will be able to test this scenario and further constrain the burst ignition site. I will further discuss the effect of this finding on measurements of the neutron-star radius through X-ray bursts.

4.6 Using mHz QPOs to put constraints on NS size and equation of state with eXTP (Holger Stiele)

Based on archival XMM-Newton data of 4U 1636-53, we studied phase-resolved energy spectra of mHz quasi-periodic oscillations (QPOs). Our study showed that the oscillations are not caused by variations in the blackbody temperature of the neutron star (NS), but revealed a correlation between the change of the count rate during the mHz QPO pulse and the spatial extent of a region emitting blackbody emission. The maximum size of the emission area allowed us to obtain a lower limit on the size of the NS that rules out equations of state that prefer small NS radii. Here we will discuss how eXTP will allow us to better constrain the lower limit on the NS radius, which together with better estimates of the hardening factor and distance, will allow for improved discrimination between different equations of state and compact star models.

4.7 Polarized thermal emission from strongly magnetized NSs (Denis Gonzalez-Caniulef)

X-ray Dim Isolated neutron stars (XDINSs) and transient magnetars (TM) are ideal laboratories to study the properties of matter and vacuum in presence of strong magnetic fields. In particular, the magnetic field in these objects is high enough (B > 1e+13 G) that it can drive a phase transition in the star surface layers turning them into a condensate. Moreover, ultra-strong fields induce QED vacuum polarization effects in the region around the star, producing observable signatures on the thermal radiation. In this talk, I will discuss the polarization properties of the thermal radiation from XDINSs and TM and how optical and X-ray polarimetry observation in the energy range of future mission, such as eXTP, can allow us to investigate and constrain physical processes in strong magnetic fields.

4.8 Comparing origins of low-frequency QPOs with spectral-timing (Abigail Stevens)

Observations suggest that different types of low-frequency quasi-periodic oscillations (QPOs) are associated with different emitting-region geometries (e.g. disk-like or jet-like) in the innermost part of the X-ray binary, close to the neutron star or black hole. We developed a technique for phase-resolved spectroscopy of QPOs, and apply it to Type B and Type C low-frequency QPOs from the black hole X-ray binary GX 339-4. On the QPO time-scale, we find that the energy spectrum changes not only in normalization, but also in spectral shape, and the two different QPOs show markedly different spectral changes. In our previous work, we inferred that the Type B QPO could be caused by a large-scale-height (i.e., jet-like) precessing region illuminating and heating overlapping azimuthal regions of the inner accretion disk. Preliminary results of the Type C QPO indicate that a small-scale-height disk-like precessing region may be responsible for the observed spectral changes. New high-resolution X-ray data from eXTP will help provide more stringent tests of these and other models of low-frequency QPOs.

4.9 Observing SS 433 with eXTP (Herman Marshall)

In the binary system SS 433, oppositely directed, precessing jets emit line emission from highly ionized plasma moving at 0.26c from the compact object. In Chandra HETGS observations of SS 433, we found a large Doppler shift change on a time scale of 20 ks, a time much shorter than the known dynamical times. The rapid change could be related to the formation and ejection of a jet knot, as observed in VLBI observations, perhaps as a leptonic jet impinges on a disk wind and shock heats it. We will report on results from new HETGS observations of the SS 433 jets and show how eXTP observations could help elucidate the nature of jet formation and propagation. The eXTP LAD is needed to examine rapid variability and specially to track Doppler shift changes of highly ionized Si, Fe, and Ni on time scales comparable to the cooling time at the base of the jets. The SFA will provide better spectral resolution in the emission lines and resolve the hard emission of the lobes, where the jets interact with the ISM. The PFA can be used to discern the polarized emission fraction from nonthermal regions, which could contribute significantly at 5 keV.

4.10 The X-ray polarization of reprocessed emission in black hole systems (Rene W. Goosmann)

The innermost part of the accretion and ejection flow around black holes can be probed in X-rays. Still, understanding the observed spectroscopic, timing, and soon (hopefully!) polarimetric X-ray data is a challenge. The complexity seen in the data reflects a non-trivial radiative interplay between jets, winds, accretion disks, or advection-dominated accretion flows. Accurate radiative transfer simulations must include the subsequent reprocessing inside these different media. I present a new set of reprocessing models with high spectral energy resolution and polarization information. The latest version of the model takes into account all 3D angular dependencies for the incident and reprocessed spectra of a weakly to highly ionized cloud. The model can be applied to spectral analyses of present-day data and provide predictions for future X-ray polarimetry observations. Thanks to its geometrical detail, it can also be used to extract spectral information from (GR-)MHD simulations of matter flowing in the vicinity of black holes.

4.11 Quasi-periodic modulation of accreting millisecond X-ray pulsars (Peter Bult)

Accreting millisecond X-ray pulsars are powerful laboratories for accretion physics. The coherent pulsations observed from such objects offer a measurement of the neutron star rotation rate, and a direct probe of the stellar surface. The pulsations themselves are powered by funneled accretion of in-flowing matter. That accretion flow, however, is variable in its own right, with quasi-periodic oscillations giving the potential to probe accretion physics and the bulk flow of matter in strong-field GR. It may be expected that periodic and quasi-periodic variability of accreting millisecond pulsars show coupled behavior, the details of which give a unique view of the flow of matter in the closest vicinity of the neutron star surface. In this contribution I will present the discovery of quasi-periodic pulse amplitude modulation in an AMXP, show the methods developed to detect them, and discuss how the high throughput X-ray observations afforded by eXTP may enable pulse amplitude modulation studies to constrain the physics of accretion.

4.12 Quantitative tests of propagating mass accretion rate fluctuations: achievements and challenges (Stefano Rapisarda)

Over the past 20 years, a consistent phenomenology has been established to describe the variability properties of Black Hole X-ray Binaries (BHBs). However, the physics behind the observational data is still poorly understood. The recently proposed model PROPFLUC assumes a truncated disc/hot inner flow geometry, with mass accretion rate fluctuations propagating through a precessing inner flow. These two processes give rise respectively to broad band variability and a quasi-periodic oscillation (QPO). In this scenario, because of propagation, the emission from different regions of the disc/hot flow geometry is correlated, so that high quality data spanning a broad energy range is required to effectively test the model. PROPFLUC was successfully applied to Swift data on the black hole MAXI J1653-152, fitting jointly the power spectra in two energy bands and the cross-spectrum between these two bands. This represents the first study to utilize quantitive fitting of a physical model simultaneously to observed power and cross-spectra. Recently, we tested PROPFLUC on the black hole XTE J1550-564, in particular we analyzed RXTE data of the rising phase of its 1998 outburst. In our study, we found quantitative and qualitative discrepancies between model predictions and data. We concluded that those discrepancies are generic to the propagating fluctuations paradigm. Through the Spectroscopic Focusing Array and the Large Area Detector, eXTP will provide high quality, high time resolution data spanning a broad energy range. This data would allow to further, quantitatively, explore the propagating fluctuations scenario both using the model PROPFLUC and analyzing the spectral-timing properties of BHBs in different energy bands.

4.13 The effects of spectral hardness changes on reverberation lags (Guglielmo Mastroserio)

Accreting black holes show characteristic reflection features in their X-ray spectrum, including an iron K alpha line, which result from hard X-ray continuum photons illuminating the accretion disk. Measuring the reverberation lag resulting from the difference in path length between direct and reflected emission, and the spectral distortions to the iron line caused by rapid orbital motion and gravitational redshift, provides a powerful tool to probe the innermost regions around the black hole. Up to now clear features of reverberation lag have been detected only in supermassive black hole systems, stellar-mass black holes have not enough signal to noise to detect them. The large effective area of eXTP will allow it to collect enough photons to observe the iron line feature in the lag energy spectrum, even for stellar-mass black holes. The models used to describe this feature ignore the non-linear effects caused by the hardening of the direct emission. We have been studying a new self-consistent model for the lags accounting for these effects in a pivoting continuum power-law and their consequences on the reflection. We have started applying this model to existing data as a proof of concept, though with the precision of eXTP data we will be able to constrain model parameters measuring mass and spin of the black hole.

4.14 Testing the relativistic precession model using low frequency and kHz quasi-periodic oscillations in NSLMXBs with known spin (Marieke van Doesburgh)

Using RXTE archival data, we have characterized the frequency correlations between LF (<100 Hz) and kHz QPOs (>200 Hz) in NS-LMXBs with known spin that are not persistent pulsars. We compare these correlations to the prediction of the relativistic precession model (RPM) that, due to frame dragging, a QPO will occur at the Lense-Thirring precession frequency ν_{LT} of a test particle orbit whose orbital frequency is the upper kHz QPO frequency ν_u. We find that the correlations are described best by power laws with indices significantly exceeding the RPM prediction of 2.0. Also, there is no evidence that the neutron star spin frequency affects any of the LF QPO frequencies as would be expected for frame dragging. Finally, the observed QPO frequencies tend to be higher than the ν_{LT} predicted for reasonable neutron star specific moment of inertia. In the light of recent successes of precession models in black holes, we briefly discuss ways in which such precession can occur in neutron stars at frequencies different from test particle values and consistent with those observed. A precessing torus geometry and other torques than frame dragging may allow precession to produce the observed frequency correlations, but can only explain one of the three QPOs we find in the ν_{LT} range. With high resolution X-ray timing data from e-XTP we will be able to refine the characterization of LF-QPOs in NS systems, and ultimately make a detailed comparison to those in LMXBs with a black hole primary.

4.15 Matter at extreme densities: models and open problems (Ignazio Bombaci)

Neutron stars are remarkable natural laboratories that allow us to investigate the constituents of matter and their interactions under extreme conditions that cannot be reproduced in terrestrial laboratories. In this talk, I will briefly discuss some of the present models to describe the equation of state of strongly interacting dense matter and their application to neutron star physics. In particular, I will focus on some open problems as the so-called hyperon puzzle in neutron stars and the possible presence of a quark deconfined phase, thus considering the so-called quark stars. Finally, I will discuss the astrophysical consequences of the possible conversion process of hadronic stars to quark stars.

4.16 eXTP and Optical Polarimetry in the ELT Era (Andrew Shearer)

The launch window of eXTP matches the expected first light of the next generation of optical and near-infra-red telescopes. This talk will look at the current state of optical polarimetry and explore potential synergies between existing and future fast polarimeters and eXTP. Neutron stars and whites dwarfs both isolated and in close binary systems have associated polarised emission which varies on short time scales, down to micro seconds. They are consequently prime targets for simultaneous optical and X-ray observations which require instruments and detectors of similar polarimetric and temporal sensitivity.

4.17 Winds and high energy flares in GRO J1655-40 (Emrah Kalemci)

We have investigated the complex multi-wavelength evolution of the microquasar GRO J1655-40 during the rise of its 2005 outburst. We detected two hard X-ray flares, the first one during the transition from the soft state to the ultra-soft state, and the second one in the ultra-soft state. The first X-ray flare coincided with an optically thin radio flare. Fitting the entire RXTE data set with phenomenological and Comptonization models show that wind related absorption features are present in the soft and ultra-soft state, together with the optically thin radio flare. We have also investigated the radio to optical spectral energy distribution, tracking the radio spectral evolution through the quenching of the compact jet and rise of the optically thin flare, and interpreted all data using state transition models. At the end of the talk, we will make a connection between the 2005 RXTE dataset of GRO J1655-40 and what eXTP can achieve in the future in terms of the relation between winds, jets and state transitions in Galactic black hole transients.

4.18 Accretion and rotation power in transitional millisecond pulsars (Alessandro Papitto)

Neutron stars in low mass X-ray binaries are spun-up to millisecond spin periods by the accretion of matter transferred by a companion star. At the end of a Gyr-long X-ray bright phase, a millisecond radio pulsar powered by the rotation of the neutron star magnetic field turns on. After decades of searches, the evolutionary link between low mass X-ray binaries and radio millisecond pulsars has been recently proven by the discovery of three sources that were observed to swing between accretion (X-ray bright) and rotation (radio bright) pulsar behaviour. State transitions take place in response to variations of the rate of mass in-flow, on time scales as short as a couple of weeks. These newly discovered pulsars are ideal test-beds to investigate the interaction between accretion flows and neutron star magnetospheres and the evolution of binary systems, and they also open new possibilities to probe the state of dense matter inside neutron stars. I will summarize the main observed properties of transitional millisecond pulsars, focusing on the leap made possible by the advent of large area X-ray detectors.

4.19 Supergiant Fast X-ray Transients with eXTP (Patrizia Romano)

Supergiant Fast X-ray Transients are HMXBs with OB supergiant companions, characterized by hour-long X-ray outbursts during which their luminosity increases by 3-6 orders of magnitude. eXTP will allow us to dramatically deepen the knowledge of this class of sources by extending the previous studies which could only concentrate either on relatively short high-sensitivity pointed observations, or on shallow-sensitivity monitoring provided by wide field cameras. eXTP will allow simultaneous high S/N broad-band and time-resolved spectroscopy of SFXTs in several intensity states, as well as long term monitoring that will yield new determinations of their orbital and spin periods. The WFM will detect all SFXT flares within its field of view down to a 15-20 mCrab in 5 ks. We present the results of our simulations based on Swift broad-band and detailed XMM-Newton observations collected so far, that describe the outbursts at several intensities, the intermediate and most common state, and the low state, from ~E-8 to ~5E-13 erg/cm2/s (0.2-10 keV). The presence of the SFA, in particular, will be fundamental in studying the large variations of NH and the presence of emission lines, that characterize the Swift and XMM spectra recorded in different instances from several SFXT sources.

4.20 Polarized X-ray emission from compact objects with eXTP (Ilaria Caiazzo)

Observing the polarization of the X-ray emission from compact objects with eXTP will provide us with information on the geometry of the emission region with unprecedented resolution. In order to truly understand future observations though, it is important to take into account the effect of QED vacuum birefringence. This effect, which was one of the first prediction of QED and which may have been recently discovered, can modify dramatically the polarization of light traveling through the magnetosphere of neutron stars and black holes. We show that QED effect on X-ray polarization from accreting black holes is significant in the eXTP energy range. Moreover, it can be used as a tool to probe the magnetic field structure of the accretion disk and to verify the role of magnetic fields in astrophysical viscosity.

4.21 Development of X-ray imaging telescope optics for eXTP mission (Zhanshan Wang)

The enhanced X-ray Timing and Polarization (eXTP) satellite requires the X-ray imaging telescopes with the effective area of about 1 square meter and angular resolution of 1 arcminute. The large collecting areas can be obtained by tightly nested shells of grazing incidence mirrors in a conical approximation Wolter-I structure. The segmented mirrors are formed by thermally slumped glass substrates coated with thin films for high reflectivity in the 1-10 keV region. In order to force the overall shape of the nominally cylindrical substrates to the appropriate conic form, an over-constraint method was used to assemble the mirrors to the telescope. Recently, the slumping process is optimized for high quality slumped glass substrates. The figure errors are in the range from 80 to 120 arcseconds, which is much better than those before above 170 arcsecond. The best glass substrates are about 60 arcsecond now. The new designed coatings are studied and showed good reflectivity in the interested region. We also optimized the assembly flow and obtained some good integrated parameters. The results demonstrated that the angular resolution caused by the assembly was roughly less than 1 arcminute. All of the results above showed that the angular resolution of the imaging telescope can achieve less than 2 arcminutes.

4.22 Probing Galactic Center Cosmic-rays with X-ray Polarimetry (Shuo Zhang)

A unique phenomenon in the Galactic Center is the existence of numerous non-thermal radio and X-ray filaments, the majority of which are associated with giant molecular clouds. Recent X-ray and radio observations suggest that some non-thermal filaments are magnetic flux tubes, where highly-ordered strong magnetic field traps GeV/TeV electrons and produces synchrotron emission in the radio/X-ray band. TeV cosmic-ray electrons are required to produce synchrotron emission up to tens of keV within the X-ray filament. However, the origin of these very-high-energy cosmic-ray electrons has remained unclear. I proposed that the TeV cosmic-ray electrons powering magnetic flux tubes are secondary productions of PeV cosmic-ray proton and molecular cloud interaction, which is fortified by a recent H.E.S.S. result pointing to the existence of a PeVatron in the Galactic Center. I will introduce my plan to use the X-ray filaments and molecular clouds to probe the cosmic-ray population in the Galactic Center, and the exciting role X-ray polarization measurements could play in the future.

4.23 A sub-keV X-ray Polarimeter (Herman Marshall)

I will describe a design for a sub-keV X-ray polarimeter using multilayer (ML) coated mirrors. The instrument could be added to eXTP, complementing the Polarimetry Focusing Array (PFA) and Spectroscopic Focusing Array with moderate resolution spectro-polarimetry in the 0.15-0.7 keV band. The method uses critical angle transmission gratings developed at MIT, laterally graded ML coated mirrors, focusing optics, and CCD detectors. We have designed a ML polarimeter for a sounding rocket that is capable of detecting the linear polarization of Mk 421 at the 10% level in only 300 s. In a 200 ks exposure, a ML polarimeter on eXTP of the same design observing 3C 273 (at 2.5 mCrab) could achieve minimum detectable polarizations (MDPs) of 2-5% in each of 6 independent sub-bands across the 0.15-0.7 keV band. Such a measurement would compare well to the PFA, which could achieve an MDP of 5% in the same time for the 2-10 keV band. Polarization measurements below 1 keV can be used to test QED effects in magnetars by comparing to measurements in the 2-10 keV range. Similarly, polarization angles are expected to rotate by 90deg from low to high energy in accretion disk systems where light bending effects dominate the polarization at high energies. Other potential science targets will be discussed.

5 Posters

5.1 Polarization signatures of diskoseismic oscillation modes (Jiri Horak)

We explore polarization light-curves for several oscillation modes of thin accretion disk. We demonstrate that the polarimetry is a valuable tool that allows to distinguish among various models of X-ray variability.

5.2 Influence of a polarized primary source on the X-ray polarization resulting from disc reflection in AGN (Michal Dovciak)

Theoretical computations showed that the reflection of X-ray radiation from the accretion disc in AGN should result in significant (detectable) polarization signals. Originating from a primary power-law coronal emission situated above the disc surface, X-ray photons are partially reprocessed by Compton scattering in the disc material and show a polarization level that heavily depends on geometry of scattering. In this contribution, we examine the polarization that can be obtained in the lamp-post geometry scenario, where a compact patch of corona is positioned on the axis above the black hole. The influence of differently polarized primary source will be presented.

5.3 Detection of a possible X-ray Quasi-periodic Oscillation in the Active Galactic Nucleus 1H 0707-495 (Haiwu Pan)

Quasi-periodic oscillation (QPO) detected in the X-ray radiation of black hole X-ray binaries (BHXBs) is thought to originate from dynamical processes in the close vicinity of the black holes (BHs), and thus carries important physical information therein. Such a feature is extremely rare in active galactic nuclei (AGNs) with supermassive BHs. Here we report on the detection of a possible X-ray QPO signal with a period of 3800 s at a confidence level >99.99% in the narrow-line Seyfert 1 galaxy (NLS1) 1H 0707-495 in one data set in 0.2-10 keV taken with XMM-Newton. The statistical significance is higher than that of most previously reported QPOs in AGNs. The QPO is highly coherent (quality factor Q~15) with a high rms fractional variability (~15%). A comprehensive analysis of the optical spectra of this AGN is also performed, yielding an estimate for the central BH mass from the broad emission lines based on the scaling relation. The QPO follows closely the known frequency-BH mass relation, which spans from stellar-mass to supermassive BHs. We suggest that the (high-frequency) QPOs tend to occur in highly accreting BH systems, from BHXBs to supermassive BHs. Future precise estimation of the BH mass may be used to infer the BH spin from the QPO frequency.

5.4 X-ray Spectral-timing Study Reveals the Properties of a super-Eddington Accretion Flow in a Type-1 AGN (Chichuan Jin)

We report the results from a latest 130 ks XMM-Newton observation of a highly super-Eddington narrow-line QSO RX J0439.6-5311. This source has one of the steepest hard X-ray spectra, superposed by a prominent and smooth soft X-ray excess. The soft X-rays show significant low frequency variabilities below 0.1 mHz, while the hard X-rays show stronger high frequency variabilities. Spectral-timing analysis using the time-averaged spectra and frequency-dependent RMS and covariance spectra suggests that the soft excess is dominated by a separate highly variable component, and also contains a stable disc-like component. The high frequency covariance spectra show that seed photons for the Comptonization in the hot corona have a higher temperature than those from the inner disc, so that they must come from the soft excess. Besides, we find the hard X-ray variability lags behind the soft by 3-4 ks in the low frequency band. Our study supports the physical scenario that the soft excess in RX J0439.6-5311 originates from a low temperature, optically thick Comptonization region that is at several tens of Rg radii, lying between a geometrically thick inner disc region and the hot corona close to the black hole. Electrons in this soft X-ray region up-scatter disc photons to produce the soft excess, thereby providing high temperature seed photons for the hot corona where the hard X-rays are produced

5.5 The LOFT/LAD background simulations and their implications for eXTP (Riccardo Campana)

A brief overview of the in-orbit radiative environment foreseen for the low-Earth equatorial LOFT orbit will be given, together with a discussion on the LOFT/LAD mass model and the Geant4 Monte Carlo simulations of the instrumental background with its short and long-term variations. Similarities and differences with the current baseline eXTP/LAD configurations will be also discussed.

5.6 Revisiting the statistical significance of the detections of oscillations in type I X-ray bursts observed by RXTE (Anna Bilous)

Type I thermonuclear X-ray bursts in the low-mass X-ray binaries occur when material accreted from the companion explodes on the surface of a neutron star. For the reasons not entirely understood about 10% of such bursts develop asymmetric brightness patches, which are further observed as modulations of X-ray flux with (approximately) the spin period of a neutron star. These modulations, called burst oscillations, are the unique tools for exploring the nuclear burning in the strong gravity/magnetic fields on the neutron star surface, as well as for probing the state of matter under the most extreme conditions inside the star itself. Thus, describing properties of burst oscillations (in particular, the evolution of oscillation frequency within the burst) is very important. Most of the observed oscillations, however, are rather weak and therefore a special attention should be paid for discerning them from noise. The previously conducted searches for burst oscillations relied mostly on the theoretical models of noise behaviour, which, in some cases, may not be entirely correct. We present the results of the thorough study of the statistical properties of real noise (based on the data from Rossi X-ray Timing Explorer satellite) and for the first time perform a uniform search for burst oscillations in all type I bursts observed by this satellite. We discuss both detections and non-detections of oscillations and compare our results to the previous findings.

5.7 High-throughput Light-weight Thin Aluminum Foil X-ray Mirror (Takashi Okajima)

NASA's Goddard Space Flight Center (GSFC) has been developing aluminum thin foil X-ray mirrors for three decades now. GSFC has flown 18 X-ray imaging mirrors and 56 X-ray concentrates on the previous space flight missions, such as ASCA, Suzaku, Hitomi and NICER. The aluminum foil X-ray mirror provides large collecting area with low mass, yielding the highest area to mass ratio among all type of X-ray mirrors flown in the past, one order of magnitude better than that of Chandra/XMM-Newton, at very low cost. Because of the long heritage of the development and the flight projects, the aluminum X-ray mirror is extremely low risk in cost and schedule. It can only produce a moderate angular resolution of about 1 arcmin, but it is the best X-ray mirror for spectroscopy and polarimetry, which require large collecting area or high-throughput rather than the angular resolution, at low mass and cost. In this paper, we present current state of the aluminum X-ray mirror, which was achieved by Hitomi and NICER projects, as well as our capability for the future missions, in terms of performance, mass, schedule and cost.

5.8 X-BOsS: An open-source code for neutron star X-ray Burst Oscillation Simulation (Thomas Riley)

The observable manifestation of X-ray emission from a neutron star whose surface layers are undergoing unstable thermonuclear fusion can be precisely simulated via computation of null worldlines on a general relativistic spacetime manifold. We will present our open-source code 'X-BOsS' (to be pushed to GitHub in 2017) for efficient, CPU-parallelised simulation of neutron star burst oscillation light-curves. These light-curves exhibit finite harmonic content due to rapid rotary modulation of a globally asymmetric photospheric radiation field. X-BOsS contains two light-curve codes. The first belongs to the 'star-to-observer' oblate-Schwarzschild (OS) paradigm (Morsink et al., 2007): our approach is characterised by approximation of the stellar photosphere as an axisymmetric (2+1)-submanifold embedded in a Schwarzschild spacetime. This submanifold is threaded by the timelike worldlines of stationary elements of radiating plasma which rotate about the stellar spin axis. The first temporal hyperslice of the photospheric submanifold is discretised by a mesh of cells; each cell is instantaneously occupied by an element of plasma. Given a parametrised model for the comoving radiative spectral intensity emergent from an arbitrary element of plasma, each cell of the mesh is assigned a parameter vector describing its time-independent comoving radiation field. The mesh rotates uniformly about the stellar spin axis in order to trace features of the photosphere (e.g. propagating global fluid modes, which are one possible model for the origin of global asymmetries) which may rotate at a coordinate angular frequency not equal to the spin angular frequency of the star. At each phase of rotation, the mesh is defined on a unique temporal hyperslice. Energy-resolved X-ray light-curves are computed via summation over the light-curves generated by cells of the rotating mesh. X-BOsS also supports a CPU-parallelised 'image-plane-to-star' code which is algorithmically distinct from the OS code. The spacetime for the image-plane code admits the quasi-Kerr spacetime solution (Glampedakis & Babak, 2006) and is an implementation based on both Psaltis and Johannsen (2012), and Bauback et al. (2012). We use it to: (i) perform internal consistency checks with the OS code; (ii) check the importance of higher-order spacetime effects for modelling burst oscillations with a given configuration, and thus justify application of the OS approximation; and (iii) resolve the stellar photosphere on the image-plane for approximate visualisation purposes.

5.9 Superburst Oscillations (Frank Chambers)

Superbursts are hours long X-Ray bursts with long recurrence times that are observed from accreting Neutron Stars. They are believed to be caused by unstable thermonuclear burning of carbon deep in the ocean at densities approximately 10^8 - 10^9 g cm^3 and can be triggered by even a small fraction of carbon given a sufficiently large mass of ashes. The burning is affected strongly by ash composition so these burst are a good probe of nuclear burning processes. Burst oscillations have been discovered during some superbursts, which could plausibly be caused by some form of surface mode. We present calculations of modes in the aftermath of a superburst, in a similar approach to Piro and Bildsten's 2005 work on modes in H/He burning oceans after normal Type I Bursts. The large area of eXTP offers a major opportunity to improve our understanding of this phenomenon, and to use it to constrain stellar mass and radius.

5.10 The puzzling variation of the orbital period of MXB 1659-298 (Rosario Iaria)

MXB 1659-298 is a transient Low-Mass X-ray binary system hosting a neutron star. The source shows eclipses and dips in the light curve and it has an orbital period is 7.1 hr. MXB 1659-298 went in outburst from 1976 to 1978, from 1999 to 2001 and, recently, in August 2015. Using the eight eclipse arrival times present in literature and adding 49 eclipse arrival times taken during the last two outburst of the source with Rossi-XTE, XMM-Newton, Nustar and Swift, we span a baseline of 40 years. We find that a simple quadratic ephemeris does not fit the eclipse arrival times while the eclipse arrival times are well predicted adding to the quadratic term two sinusoidal modulations with period of 2.11+/-0.04 yr and 24+/-6 yr, respectively.

5.11 Building a database of element-by-element X-ray spectral lines (Francesco Leone)

At Laboratori Nazionali del Sud X-ray spectroscopy has been developed in order to investigate magnetoplasmas excited by Electron Cyclotron Resonance. Warm and hot electrons temperature measurements, in facts, are possible by detecting the plasma emitted X radiation. In these machines, gases or vapours are turned in plasma state by microwaves in the range 2.45-28 GHz, in presence of few T magnetostatic field allowing the ECR to occur and also confining the plasma in a MHD-stable configuration. The values of plasma density, temperature and confinement times are typically ne = 10^12-10^14cm^3, Te > 0.1-100 keV, ti=0.1-1 sec. For low energy domain (E < 30keV) conventional SDD detectors have been used reaching a resolution of 125 eV at 5.9 keV. In the domain 0.4-30 keV an X-ray pin-hole camera technique has allowed space resolved X-ray spectroscopy with a spatial resolution down to 30 lm and an energy resolution down at 5.9 keV. In order to perform ion temperature measurements, X-ray fluorescence lines broadening should be measured, requiring high resolution. A novel high-resolution spectrometer is therefore now under assembling at LNS. It consists of a grating for the dispersion of the X-ray beam coming out from the plasma. The energy dispersed X-rays are then collected on a X-ray sensitive CCD camera. The grating is placed on a system of four motorized stages (x, y, z position, for the alignment, plus a rotating platform for the correct dispersion of the incoming beam) ensuring sub-micrometric precision. The operative energy domain is between 70 eV and 3.5 keV, with around 1 eV energy resolution for the Ka of the Oxygen. Systematic measurements on oxygen, neon and argon magnetoplasmas are expected for the first half of 2017. This will be a first step towards that complete database, of element-by-element spectral lines, to be built for the correct interpretation of X-ray Astronomical data.

5.12 Radiation Sensors: R&D and production at FBK Facility (Pierluigi Bellutti)

There is a long lasting experience in R&D and series production of silicon radiation sensors at FBK. The available technologies are covering a wide range of devices featuring a high degree of customization, as required by different applications. Among the sensors we mention here the large area double side microstrip detectors have developed and produced for AMS II (sensor area of about 30 cm^2) and CSES - Limadou (sensor area of about 90 cm^2); the Silicon Drift Detectors for LOFT mission (sensor area of about 75 cm^2). Other technologies under development or in production include Silicon photomultipliers, Silicon 3D Detectors, and CMOS SPAD arrays. An overview of these technologies, focusing on space applications will be given at the conference.

5.13 In-flight background simulation of the XIPE Gas Pixel Detector (Fei Xie)

The background level requirement stipulated for the XIPE mission is 8 x 10-4 cts/cm2/s/keV per Gas Pixel Detector (outside the Southern Atlantic Anomaly). The requirement is motivated by long observations of demanding sources, e.g. extended faint molecular clouds in the crowded field of the galactic center. Background estimations have been derived using background radiation fluxes implemented within the Geant4 simulation framework. The simulation includes a detailed mass model of focal plane components and also captures important details of the X-ray optics and satellite bus. Background rejection techniques exploit the imaging capabilities of the GPD allowing the interaction geometry of X-ray generated photoelectrons to be distinguished from other particle types. We present the outcome of the simulation studies and describe background mitigation strategies which have been developed.

5.14 Effects of transient accretion on millisecond pulsars (Sudip Bhattacharyya)

We will discuss a previously unrecognized effect of transient accretion on the spin-up of millisecond pulsars, i.e., fast spinning neutron stars. We numerically show that for the same long-term average accretion rate, X-ray transients can spin up pulsars to rates several times higher than can persistent accretors, even when the spin down due to electromagnetic radiation during quiescence is included. We also compute an analytical expression for the equilibrium spin frequency in transients, by taking spin equilibrium to mean that no net angular momentum is transferred to the neutron star in each outburst cycle. We find that the equilibrium spin rate for transients, which depends on the peak accretion rate during outbursts, can be much higher than that for persistent sources. This explains our numerical finding. This finding implies that any meaningful study of neutron star spin and magnetic field distributions requires the inclusion of the transient accretion effect, since most accreting neutron star sources are transients. Our finding also implies the existence of a submillisecond pulsar population, which is not observed. This may point to the need for a competing spin-down mechanism for the fastest-rotating accreting pulsars, such as gravitational radiation. This work involves accretion in high magnetic field and strong gravity, and hence will be relevant for the eXTP science. (Reference: The Astrophysical Journal, in press, 2016).

5.15 Using Leaked Power to Measure Intrinsic AGN PSD in the eXTP Era (Yongquan Xue)

Fluxes emitted at different wavebands from active galactic nuclei (AGNs) fluctuate at both long and short timescales. The variation can typically be characterized by a broadband power spectrum, which exhibits a red-noise process at high frequencies. The standard method of estimating the power spectral density (PSD) of AGN variability is easily affected by systematic biases such as red-noise leakage and aliasing, in particular when the observation spans a relatively short period and is gapped. Focusing on the high-frequency PSD that is strongly distorted due to red-noise leakage and usually not significantly affected by aliasing, we develop a novel and observable normalized leakage spectrum (NLS), which sensitively describes the effects of leaked red-noise power on the PSD at different temporal frequencies. Using Monte Carlo simulations, we demonstrate how an AGN underlying PSD sensitively determines the NLS when there is severe red-noise leakage, and thereby how the NLS can be used to effectively constrain the underlying PSD. Finally, we discuss the promising prospect of using our NLS approach in the eXTP era.

5.16 Inclination dependence of phase lags in Galactic black-hole binaries (Jakob van den Eijnden)

Quasi-periodic oscillations (QPOs) with frequencies from ~0.05 to 30 Hz are a common feature in the X-ray emission of accreting black hole binaries. As the QPOs originate from the innermost accretion flow, they provide the opportunity to probe the behaviour of matter in extreme gravity. In this talk, I will present a systematic analysis of the inclination dependence of phase lags associated with both Type-B and Type-C QPOs in a sample of 15 Galactic black hole binaries. We find that the phase lag at the Type-C QPO frequency strongly depends on inclination, both in sign and in evolution with QPO frequency. Although we find that the Type-B QPO soft lags are associated with high inclination sources, the source sample is too small to confirm this as a significant inclination dependence. Finally, our results indicate that the unknown-inclination sources XTE J1859+226 and MAXI J1543-564 are most consistent with a high inclination. I will discuss these results in the context of geometrical models of Type-C QPOs, focusing on a scenario where the phase lag originates from the recently observed pivoting of the spectral power law during each QPO cycle. In this interpretation, the observed inclination dependence arises from differences in dominant relativistic effects.

5.17 The coupling of the radiatively efficient accretion flow and the jet for the radio/X-ray correlation in black hole X-ray binaries (Erlin Qiao)

We interpret the radio/X-ray correlation of $L_{\rm R} \proptoL_{\rm X}^{\sim 1.4}$ for $L_{\rm X}/L_{\rm Edd} \gtrsim 10^{-3}$ within the framework of the coupling of a radiatively efficient accretion flow and a jet, i.e., the coupling of a disk corona and a jet. In the model, the matter in the accretion flow and the matter in the jet are connected by a parameter, `η', describing the fraction of the matter in the accretion flow ejected outward to form the jet. We calculate $L_{\rm R}$ and $L_{\rm X}$ for different $\dot M$, adjusting η to fit the observed radio/X-ray correlation of the black hole X-ray transient H1743-322 for $L_{\rm X}/L_{\rm Edd}>10^{-3}$. It is found that the value of η for this radio/X-ray correlation for $L_{\rm X}/L_{\rm Edd} > 10^{-3}$, is systematically less than that of the case for $L_{\rm X}/L_{\rm Edd} < 10^{-3}$, which is consistent with the general idea that the jet is often relatively suppressed at the high luminosity phase in black hole

5.18 Type-I burst as probe to the XRB accretion (Shu Zhang)

The evolution of an outburst from XRB highly depends on the balance between the disk and the corona. The typical viscosity time scale corresponding to a spectral transition is of hours to days, which prevents from probing the disk and corona on shorter time scale. For example, although corona has been being well used in modelling accretion of XRBs, especially on aspects of the spectral state transitions and correlation with launching of a jet, so far its nature is still less known, especially on aspect of the formation mechanism. To probe this puzzle observationally, one has firstly to have a proper probe like the intense short soft X-ray shower, since the corona is in definition less emissive and can only be lighted up with the incident soft X-rays. This probe, however, falls short in BH XRBs, but fits well the thermal nuclear flashes occurring on the NS surface. We therefore took the type-I burst to probe the accompanied disk/corona evolution. I will introduce the type-I burst probe on aspect of the current progress and of the future prospect in the context of having the Chinese missions of HXMT and eXTP.

5.19 A spectral-timing analysis of the kHz QPOs in 4U 1636-53: The frequency-energy resolved rms spectrum (Evandro Martinez Ribeiro)

Our understanding of quasi-periodic oscillations (QPO) has been further advanced in the last few years by the use of combined spectral and timing techniques, and it is now clear that QPO properties are closely related to the spectral state of the source in which they appear. In this work we used all the available RXTE observations of the neutron-star low-mass X-ray binary 4U 1636-53 to study the properties of the kilohertz QPO as a function of energy and frequency. By following the frequency evolution of the kHz QPOs we created frequency-resolved fractional RMS spectra. We also studied the connection between the frequency of the kHz QPOs and the parameters of the model that fits the X-ray energy spectrum. We show the dependence of the QPO properties in a multi-parameter space, and we discuss the implication of our results to the mechanism that produces the QPOs. Our results provide input to the next generation of spectral-timing models, which will help us understand the variability and the environment around the neutron star in these systems.

5.20 Time variability of NS-LMXBs as oscillation modes of relativistic axisymmetric and non-axisymmetric tori: implications for dynamical mechanisms (Marcio G B de Avellar)

There have been many efforts to explain the dynamical mechanisms and models for the origin and phenomenology of the quasi-periodic oscillations (QPOs) seen in the X-ray light curves of low-mass X-ray binaries. Up to now, none of the models on the market can address all the frequencies observed in the power density spectrum of the light curve and their properties. However, new light is shed on the problem through sophisticated simulations of accretion flows onto compact objects. We perform several hydrodynamic simulations of non-self-gravitating relativistic axisymmetric and non-axisymmetric thick tori around the neutron star in the low-mass X-ray binary 4U 1636-53 and show how the observed oscillation modes triggered by different velocity perturbations give rise to a set of variability features similar to what we see in the observational X-ray data, in particular in the case of the kiloHertz QPOs. We compare the simulated and the observational relations between the upper and lower kiloHertz QPOs frequencies to probe the inner regions of the system, potentially constraining the mass and radius of the neutron star.

5.21 Characterization of the NNVT capillary plate collimator (Francesco Ceraudo)

In this paper, we report the results of the characterization campaign of the Micro-Channel Plate (MCP) designed as the X-ray collimator for the Large Area Detector (LAD) aboard the enhanced X-ray Timing and Polarimetry (eXTP) mission. The device was developed ad-hoc by North Night Vision Technology Co., Ltd. (Kunming, China). Measurements involve the study of the MCP's chemical composition through a fluorescence analysis and its angular response to X-rays (rocking curve). The whole campaign took place at the laboratories of INAF/IAPS in Rome.

5.22 An update on regular and chaotic motion in an inclined black hole magnetosphere (Vladimir Karas)

We investigate circular motion of particles, dust grains and fluids in the vicinity of compact objects as a model for accretion of complex gaseous and dusty environment. Here we further discuss, within the framework of general relativity, figures of equilibrium of matter under the combined influence of strong gravity and large-scale magnetic fields: Kerr black hole embedded in an external magnetic field in arbitrary orientation with respect to the rotation axis.

5.23 NuSTAR observations of the Neutron Star 4U 1636-53 (Yanan Wang)

We present the results of a NuSTAR study of the accreting neutron star 4U 1636-53. The source was observed three times with NuStar, in the hard, soft and intermediate state. The spectra of these three observations show a broad emission line at around 6.5 keV, likely due to iron. We fitted this line with different models of a relativistically broadened line, and a model including relativistically smeared and ionised reflection from the accretion disk. The fits require a high inclination angle of the accretion disc, around 87 degrees, even if the light curve of the source shows no dips or eclipses. We discuss the origin of this line and possible broadening mechanisms.

5.24 Super-spinning compact objects and forced resonance models of high-frequency quasi-periodic oscillations (Katka Goluchova)

In our previous work we have applied several models of high-frequency quasi-periodic oscillations to estimate the spin of the central compact object in the three Galactic micro-quasars. Among the consideration of standard Kerr black hole space-times we have assumed the possibility that the central compact body is a super-spinning object (or a naked singularity) with the external space-time described by Kerr geometry with a dimensionless spin parameter $a>1$. Here we extend our consideration and investigate in a consistent way the implications of a set of 10 resonance models so far discussed only in the context of $a<1$. For these models, there is the possibility of recognizing a direct observational signature of presence of a super-spinning compact object. Epicyclic forced resonance models predict that $a \sim 1$ and more pairs of different 3:2 commensurable frequencies can be expected within a single source. This issue can be resolvable using the large amount of high quality data available through the next generation of X-ray observatories including technologies such as the proposed concept of Large Area Detector.