Simbol–X 2nd International Symposium
Paris Dec. 2–5, 2008

List of Abstracts

Mission and instrumental

1. The Simbol–X mission

Philippe Ferrando (CEA/SAP & APC)
Oral

Authors: Ferrando P. et al.

Bringing focusing into the hard X–ray domain is the next logical step in high energy astrophysics. The Simbol–X mission, which will operate in the 0.5–80 keV domain, will provide the community with an Instrument having the angular resolution and sensitivity (two to three orders of magnitude improvement w.r.t. all current instrumentation) at the level needed for solving open issues in this domain, in particular in accretion physics and particle acceleration. In this paper, we will present the most important mission characteristics as they are at the beginning of phase B implementation.

2. Simbol–X core science

Fabrizio Fiore (INAF Roma)
Oral

Authors: F. Fiore et al.

The Simbol–X core science program.

3. Simbol–X Detector Payload

Philippe Laurent (CEA/SAp & APC)
Oral

Authors: P. Laurent, et al.

Design of the detector payload.

4. Simbol–X Optics design versus scientific and technical requirements

Giovanni Pareschi (INAF/Brera Astronomical Observatory)
Oral

Authors: G. Pareschi, G. Tagliaferri, V. Cotroneo, D. Spiga, E. Dell'Orto, G. Parodi, D. Vernani, G. Parodi

The design drivers for the Simbol–X X-ray mirror module will be addressed, taking into account the scientific requirements and the system implementation constraints. The trade-off choices leading to the final design will be reviewed.

5. The Simbol–X Low Energy Detector

Peter Lechner (PNSensor)
Oral

Authors: P. Lechner, L. Andricek, L. Bombelli, U. Briel, C. Fiorini, G. Hasinger, K. Heinzinger, S. Herrmann, H. Huber, E. Kendziorra, T. Lauf, G. Lutz, M. Porro, R. Richter, A. Santangelo, G. Schaller, M. Schnecke, F. Schopper, G. Segneri, L. Strüder, J. Treis

The Simbol–X Low Energy Detector (LED) is a Silicon imaging spectrometer with a sensitive area of 8x8cm²

to cover a 12arcmin field of view and a pixel size of 625x625µm² adapted to the telescope's resolution of 20arcsec. The additional LED specifications are:
- high energy resolution (150eV at 6keV),
- high quantum efficiency from 500eV to 20keV,
- fast readout (8000 frames per second) and optional window mode,
- monolithic device with 100% fill factor and suspension mounting to provide uniform transmission for the HED,
- operation at warm temperature (-45°C).
To match these requirements the LED is composed of 'active macro pixels', combining the large, scalable area of a Silicon Drift Detector and the low-noise, on-demand readout of an integrated DePFET (Depleted P-channel Field Effect Transistor) amplifier. Flight representative prototypes with a pixel size of 500x500µm² and a format of 64x64 pixels have been processed and characterised at the MPI semiconductor laboratory. The LED technology readiness will be demonstrated by the prototype's measured performance.

6. Simulation of the Simbol–X telescope: Results and performances

Maxime Chauvin (CESR, Toulouse)

Oral

Authors: M. Chauvin et al.

We have developed a simulation tool for a Wolter I telescope operating in formation flight. The aim is to understand and predict the behavior of the Simbol–X instrument. As the geometry is variable, formation flight introduces new challenges and complex implications.
Our code, based on Monte Carlo ray tracing, computes the full photon trajectories up to the detector plane, along with the relative drifts of the two spacecrafts. It takes into account angle and energy dependent interactions of the photons with the mirrors and applies to any grazing incidence telescope. The resulting images of simulated sources from 0.1keV to 100keV allow us to optimize the configuration of the instrument and to assess the performance of the Simbol–X telescope.

7. The High Energy Detector of Simbol–X

Aline Meuris (CEA Saclay)

Oral

Authors: A. Meuris, O. Limousin, F. Lugiez, O. Gevin, C. Blondel, I. Le Mer, F. Daly, F. Pinsard, C. Cara, A. Goetschy, J. Martignac, G Tauzin, S. Hervé, Ph. Laurent, R. Chipaux, Y. Rio, J. Fontignie, B. Horeau, M. Authier.

The High Energy Detector (HED) is one of the three detection units on board Simbol–X detector spacecraft. It is placed below the Low Energy Detector so as to collect focused photons in the energy range from 8 to 80 keV. It consists of a mosaic of 64 independent cameras, divided in 8 sectors. Each elementary detection unit, called Caliste, is the hybridization of a 256-pixel Cadmium Telluride (CdTe) detector with full custom front-end electronics into a unique component. The status of the HED design will be reported. The promising results obtained from the first micro-camera prototype called Caliste 64 will be presented to illustrate the expected performance of the instrument.

8. Calibration of Simbol–X optics at the PANTER X-ray Test Facility: facility upgrade for long focal lengths

Michael Freyberg (MPI f. extraterrestrische Physik)

Oral

Authors: M.J.Freyberg, W.Burkert, B.Budau, S.Passlack, G.Hartner, et al.

The PANTER X-ray Test Facility with ots 12m long vacuum instrument chamber has been used for development and calibration of X-ray astronomical instrumentation with focal lengths of the order of 1-10 m. Telescopes for missions like SIMBOL–X and IXO with focal lengths of 20-25m require updates to the facility layout to be able to accomodate and measure the optics with the needed accuracy. We present an outline of the

planned mirror calibration for Simbol–X, and the planned changes at PANTER. Also measaurements of IXO optics may benefit from the upgrades.

9. Simbol–X mirror development results obtained during phase A

Gianpiero Tagliaferri (INAF – OA Brera)

Oral

Authors: G. Tagliaferri, S. Basso, O. Citterio, M. Civitani, P. Conconi, V. Cotroneo, E. Dell'Orto, G. Pareschi, D. Spiga, G. Borghi, D. Garoli, V. Mattarello, G. Valsecchi, D. Vernani, S. Romaine, P. Gorenstein, W. Burkert, M. Freyberg, G. Hartner

Abstract : 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. The superb hard X-ray imaging capability will be guaranteed by a mirror module of 100 electroformed Nichel shells with a multilayer reflecting coating.
Here we will describe the technogical development and solutions adopted for the fabrication of the mirror module, that must guarantee an HEW better than 20 arcsec up to 30 keV and 40 arcsec at 60 keV and an effective area of more than 100 cm2 at 1 keV and 300 cm2 at 30 keV. During the phase A, just terminated, we have developed 3 engineering models with 2, 2, and 3 shells, respectively. We will then describe the results obtained with these models, both in terms of image quality and effective area as a function of energy.

10. SIMBOL-X : Mission profile & formation flight challenges

Rodolphe Clédassou (CNES)

Oral

Authors: R. Clédassou et al.

Abstract : after a brief system architecture description, the presentation will outline the mission profile and the challenges related to the formation flying. A link will be done between these challenges and the technological readiness levels of the sensors needed to fulfil the mission requirements

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11. SimX, mission simulator for Simbol–X observations

Sébastien Rouquette (CNES)

Poster

Authors: Rouquette S. (CNES), G. Lassalle-Balier (CNES), O. La Marle (CNES)

The Simbol–X mission simulation tool, so called SimX, will be used mainly for system studies and validation regarding at least Delta-v needs, onboard memory needs, ground station support and system capacity. Its first step will be the definition of reference observation plans, useful to conduct industrial call. It will also be useful in conducting test contexts for system qualification.
Later, it will be the first step of the definition of the simulation tool witch will be used to define the function of mission planning, developed by ground segment. In the short delay of the industrial call, the SimX tool will be used to provide reference mission profile in order to give practical cases for the system and satellite definition. These case studies might be useful to evaluate performances of the satellite in various domains as: Energy/power consumption, thermal studies, onboard memory and planning.
This talk will deal with two main aspects : a general presentation and a demonstration of SimX; a discussion about the strategy of observation plan calculation.

12. On the compliance of Simbol–X mirror roughness with the effective area requirements

Daniele Spiga (INAF/Osservatorio Astronomico di Brera)

Poster

Authors: D. Spiga, V. Cotroneo, G. Pareschi, G. Tagliaferri

Surface microroughness of X-ray mirrors is a key issue for the angular resolution of Simbol–X to comply the required one (< 20 arcsec at 30 keV). Starting from the required HEW of the Simbol–X optical module, possible microroughness requirements have already been formulated, conveniently expressed in terms of its PSD (Power Spectral Density). However, also the Effective Area of the telecope is affected by the mirror roughness. In this work we will show how the expected effective area of the Simbol–X mirror module can be computed from the roughness PSD tolerance, checking its compliance with the requirements.

13. A Fast Event Preprocessor and Sequencer for the Simbol–X Low Energy Detector

Thomas Schanz (IAAT)

Poster

Authors: T. Schanz, C. Tenzer, D. Maier, E. Kendziorra, A. Santangelo

The Simbol–X Low Energy Detector (LED), a 128 x 128 pixel DEPFET (Depleted Field Effect Transistor) array, will be read out at a very high rate (8000 frames/second). This requires very fast onboard electronics, consisting of an Event Preprocessor (EPP) and a related Sequencer (SEQ) design. We present an FPGA (Field Programmable Gate Array) based solution which can fulfill the requirements. The design is developed in the hardware description language VHDL (VHSIC Hardware Description Language) and can later be ported to an ASIC (Application Specific Integrated Circuit) technology. The EPP performs a pixel related offset correction and can apply different energy thresholds to each pixel of the frame. It also provides a line related common-mode correction to reduce noise that is unavoidably caused by the analog readout chip of the DEPFET. An integrated pattern detector can block all invalid pixel patterns. The EPP has an internal pipeline structure and can perform all operations in realtime (< 2us per line of 64 pixels) with a base clock frequency of 100 MHz. It is utilizing a fast median-value detection algorithm for common-mode correction and a new pattern scanning algorithm to select only valid events. The SEQ is also part of the FPGA-design and generates all necessary signals to control the operation and readout of the LED.

14. Simbol–X Telescope Thermal Shields: I - Design and X-ray transmission

Alfonso collura (INAF-OAPA)

Poster

Authors: A. Collura, M.Barbera, S. Basso, G. Pareschi, G. Tagliaferri, T. Ayers

The Simbol–X mission is designed to fly in formation flight configuration. As a consequence, the telescope has both ends open to space, and thermal shielding at telescope entrance and exit is required to maintain temperature uniformity throughtout the mirrors. Both mesh and meshless solutions are presently under study for the shields. We discuss the design and the X-ray transmission.

15. Simbol–X Mirror Module Thermal Shields: II - Small Angle X-Ray Scattering Measurements

Marco Barbera (Università degli Studi di Palermo - Dipartimento di Scienze Fisiche ed Astronomiche)

Poster

Authors: Marco Barbera, Travis Ayers, Alfonso Collura, Giorgio Nasillo, Giovanni Pareschi, Gianpiero Tagliaferri

The formation flight configuration of the Simbol–X mission implies that the X-ray mirror module will be open to Space both on the front end, facing the observed portion of Sky, and on the back end, facing the detector satellite. In order to reduce the power required to maintain the thermal stability and, therefore, the high angular resolution of the shell optics, a thin foil thermal shield will cover the mirror module on both ends. Different options are presently being studied for the foil material of these shields. We report results of an experimental

investigation conducted on different samples to verify that the scattering of X-rays, by interaction with the thin foil material of the thermal shield, will not significantly affect the performances of the telescope.

16. A Simbol–X event simulator

Simonetta Puccetti (Asi Science Data Center)

Poster

Authors: Puccetti S. et al.

The ASI Science Data Center (ASDC) has developed an X-ray event simulator to support users (and team members) in simulation of data taken with the two cameras on board of the Simbol–X X-Ray Telescope. The Simbol–X X-ray event simulator is a fortran program, which includes some routines of HEADAS package. The Simbol–X X-ray event simulator is aimed at providing a fast, flexible and multi-mission-oriented tool to support the user in planning proposals and comparing real data with the theoretical expectations for a quick detection of unexpected features. We present here the simulator outline and some examples of simulated data.

17. Formation Flying and deformable instruments: Think Different

Yvon Rio (CEA Saclay)

Poster

Authors: Yvon Rio et al. (exact list will be decided later)

Astronomers have always attempted to build very stable instruments. They fight all that can cause mechanical deformation or image motion. This has led to well established technologies (autoguide, active optics, thermal control, tip/tilt correction), as well as observing methods based on the use of controlled motion (scanning, microscanning, shift and add, chopping and noding). Formation flying disturbs this practice. It is not possible either to reduce the relative motion to very small amplitudes, nor to control it at will. Some impacts on SimbolX instrument design, and operation are presented.

18. Imaging performance analysis of Simbol–X with simulations

Maxime Chauvin (CESR, Toulouse)

Poster

Authors: M. Chauvin

Using the simulation tool we have developed (see Chauvin et al, these proceedings), we have conducted detailed analysis of Simbol–X imaging performance.
We will illustrate the effects of different parameters (mirror roughness, relative drifts of the spacecrafts and accuracy of the sensors) on the performances of the Simbol–X telescope. These effects are quantified as a function of photon incidence and energy and allow us
to discuss several telescope configurations.

19. Formation flight and image reconstruction for Simbol–X

Marta Civitani (INAF)

Poster

Authors: Marta Civitani, Sophie Djalal, Remi Chipeaux, Jean-Michel Duigou, Olivier La Marle

Simbol–X is the first operational mission relying on two satellites flying in formation. The mirror satellite (MSC), carrying the mirrors of the telescope, moves freely on a high elliptical orbit controlling its attitude towards the target, while the detector satellite (DSC) will keep the detector assembly around the mirror focal point. The DSC will control its 3- axis position respect to the MSC and its attitude respect to the target. The formation flight concept raises a variety of problematics, like image degradation, that can be better evaluated via a simulation tools . The aim of this work is to present the first results obtained with a simulation tool build in

cooperation between CNES, INAF and CEA for studying the relative navigation and the relative weight of the different parameters in telescope performance evaluation. The simulation rely on attitude and formation flight sensors models, formation flight dynamics and control, mirror model and focal plane model, while the image reconstruction is based on the Line of Sight (LOS) concept.

20. The integration of very thin mirror shells

Stefano Basso (INAF- Osservatorio di Brera)

Poster

Authors: S. Basso

The optics of Simbol–X are very thin compared to the previous X-ray mission (like XMM). Such thickness makes the shells floppy and therefore unable to maintain the correct shape. The integration is the operation that freeze the shape of the shells gluing them into the mechanical structure. It is clear that before gluing, the shape of the shell must be as good as possible. To solve the problem of the deformations of very thin X-ray optics we adopt two stiffening rings with a good roundness. In this article the procedure used in the first three prototypes of the Simbol–X optics is presented with a description of the problems involved and with an analysis of the degradation of the performances during the integration. This was achieved with the UV vertical bench measurements at INAF – Osservatorio di Brera.

21. A magnetic diverter for charged particle background rejection in the Simbol–X telescope

Elisa Dell'Orto (INAF-OAB)

Poster

Authors: Dell'Orto, Spiga et al.

Some x-ray missions, as Newton-XMM and CHANDRA, showed a degradation of the detector performance due to protons with energy between 100 keV and few MeV, that are focused on the focal plane through the mirror module. The focusing of the protons by Wolter optics was an unexpected phenomenon. The physical interaction between charged particles and the reflective surface of X-ray mirrors isn't yet well understood yet even if different models were suggested, that give different angular and energy distribution for the proton that leave the optics. In order to reduce the flux of charged particles a magnetic diverter could be developed also to deflect protons. Obviously the design of the diverter should take into consideration the actual protons distribution at the exit of the mirror module, for this reason a detailed simulation about the interaction of particles with the front and rear surface of mirrors is necessary.

22. Status of the Simbol-X Background Simulation Activities

Christoph Tenzer (IAA Tübingen)

Authors: C. Tenzer, U. Briel, A. Bulgarelli, R. Chipaux, V. Fioretti, L. Foschini, S. Hauf, E. Kendziorra, M. Kuster, P. Laurent, A. Tiengo

The Simbol-X background simulation group is working towards a simulation based background and mass model which can be used before and during the mission. Using the Geant4 toolkit, a Monte-Carlo code to simulate the detector background of the Simbol-X focal plane instrument has been developed with the aim to optimize the design of the instrument. Achieving an overall low instrument background has direct impact on the sensitivity of Simbol-X and thus will be crucial for the success of the mission. We present results of recent simulation studies concerning the shielding of the detectors with respect to the diffuse cosmic hard X-ray background and to the cosmic-ray proton induced background. Besides estimates of the level and spectral shape of the remaining background expected in the low and high energy detector, also anti-coincidence rates and resulting detector dead time predictions are presented. The poster is aimed at giving an overview of all the ongoing simulation activities.

23. Simbol–X background minimization: mirror spacecraft passive shielding trade-off study

Valentina Fioretti (University of Bologna - INAF/IASF Bologna)

Poster

Authors: V. Fioretti, G. Malaguti, A. Bulgarelli

The scientific requirements and the advanced design of Simbol–X imply the necessity of great care in the minimization of the background radiation at high energy.

The background can be broadly divided into two main categories: (a) the diffuse CXB reaching the detector from directions outside the focusing system, and (b) the hadronic component originated by prompt and delayed events caused by high energy particles.

The minimization of the photonic component is generally achieved by means of a high Z passive shield. Since the formation flight architecture avoids the possibility of using the canonical telescope "tube" connecting the mirror to the focal plane unit, Simbol–X passive shielding system consists of two main parts: the collimator tube placed on top of the focal plane (detector baffle), plus a circular passive shield around the mirror module (sky screen).

The present work shows a quantitative trade-off analysis of the Mirror Spacecraft (MSC) sky screen, in the phase space of the variuos parameters: mass budget, dimension, geometry, and composition. A simplified physical (and geometrical) model of the sky screen, implemented by means of a GEANT4 simulation, has been developed to perform a performance-driven mass optimization and evaluate the residual background level on Simbol–X focal plane.

24. The Simbol–X AntiCoïncidence

Julien Chabaud (Laboratoire APC - AstroParticules & Cosmologie)

Poster

Authors: J. Chabaud, J.J. Jaeger, P. Laurent, S. Colonges, J. Barbay, J.P. Baronick, M. Benallou, P. Ferrando, J. Waisbard, B. Yoffo

The Simbol–X telescope will be constituted by two satellites in formation flight. One will host the mirror module and the other the detector payload. This payload will be built with two main detectors able to measure the position, energy and arrival time of each focused photon, between 0.5 and 80 keV.

The high sensitivity required by Simbol–X will necessitate low background detectors. To achieve this goal, those detectors will be surrounded by a passive graded shield, aimed to stop the out of field of view photons, and an active anticoincidence system to tag the passing particles. This anticoïncidence detector, whose conception, optimisation and realization are under responsibility of the APC laboratory, Paris, is based on plastic scintillator plates associated to multi-anodes photo-multipliers via optical fibbers. In this poster, we will present the present status of the anticoïncidence system and its expected performances.

25. Simbol–X telescope scientific calibrations: requirements and plans

Giuseppe Malaguti (INAF/IASF-Bologna)

Poster

Authors: G. Malaguti, A. Moretti, L. Raimondi, M. Trifoglio

The scientific calibration of the Simbol–X telescope at end-to-end level will face a number of unprecedented issues. First of all, the 20m focal length, which implies that the incoming X-ray beam divergence is comparable to the incidence angle of the mirror surface also for 100m-long facilities. Moreover, for the first time a direct focussing X-ray telescope will be calibrated on an energy band covering about three decades, and with an hybrid focal plane with two detectors placed one above the other. These problems imply a careful organization of the measurements requirements and plans, together with an evaluation of the needs in terms of both hardware and software.

26. Effects of small oscillations on the effective area of the optics

Vincenzo Cotroneo (Brera astronomical observatory)

Poster

Authors: Cotroneo V., Pareschi G., Tagliaferri G., Cusumano G.

The effective area of the Simbol-X mirrors in dependence of the off-axis angle is extimated for small oscillations, in relation with the mirror coating and geometrical parameters.
A reduction is expected due to geometrical effects, because some of the photons miss the secondary mirror surface, and to reflectivity effects, caused by the variation of the coating reflectivity with the incidence angle.
The former are related to the lenght of the two mirror surfaces and can reduced by making the secondary mirror longer. The second ones are energy-dependent, and strongly depends on the characteristics of the reflecting coating.
These effects are analyzed by ray-tracing calculation in order to optimize the mirror and coating design with the aim of improving the effective area stability.

27. 9 year of XMM–Newton pipeline: Experience and Feedback

Laurent MICHEL (Observatoire de Strasbourg)

Poster

Authors: L MICHEL C. MOTCH

The Strasbourg Observatory is member of the Survey Science Center of the XMM-Newton satellite. We run the part of the general data processing pipeline performing the cross-correlations of EPIC sources with archival catalogs. This task was developed in Strasbourg and is flawlessly in operation since the launch of the satellite in 1999. The presentation will describe the work load and infrastructure required by this activity but also the benefits returned to our team. We will show how our nine year long experience could be used in the framework of the Simbol–X ground segment.

28. Mining connected data: XMM–Newton experience

Laurent MICHEL (Observatoire de Strasbourg)

Poster

Authors: L MICHEL C. MOTCH

As members of the Survey Science Consortium of the XMM-Newton mission
the Strasbourg Observatory is in charge of the real-time cross-correlations of X-ray data with archival catalogs. We also are committed to provide a specific tools to handle these cross-correlations and propose identifications at other wavelengths. In order to do so, we developed a database generator (Saada) managing persitent links and supporting heterogeneous input datasets. This system allows to easily build an archive containing numerous and complex links between individual items. It also offers a powerfull query engine able to select sources on the basis of the properties (existence, distance, colours) of the X-ray - archival associations. We will present such a database in operation for the 2XMMi catalogue. This system is flexible enough to provide both a public data interface and a servicing interface which could be used in the framework of the Simbol–X ground segment.

29. POLARIX, a X-ray polarimetry mission

Giorgio Matt (Universita' Roma Tre)

Poster

Authors: Giorgio Matt on behalf of the POLARIX team

POLARIX is a X-ray polarimetry mission, selected for Phase A study within the Italian Space Agency programme for small missions.

The characteristics of the mission and its main scientific objectives will be described. If eventually selected, POLARIX will fly in the same timeframe as Simbol–X. Open astrophysical issues which will benefit from observations from both missions will be highlighted.

Highlights

30. The Hard X-ray Sky: Recent Observational Progress

Neil Gehrels (NASA-GSFC)

Highlight Talk

Authors: Neil Gehrels
NASA-GSFC

Until recent progress with INTEGRAL and SWIFT, the hard X-ray sky had been only poorly explored. The previous hard X-ray sky survey by HEAO-A4 in the late 1970's was complete at only the ~20 mCrab level. Even at that sensitivity, interesting results were obtained with the detection of a dozen bright, now-famous AGN. INTEGRAL and SWIFT are now surveying at sub-mCrab levels and detecting hundreds of galactic and extragalactic sources of all types, including clusters, Seyferts, blazars, accreting binaries, flare stars, and supernova remnants. Absorbed sources are being discovered both in the Galaxy and AGN. The fraction of absorbed and Compton thick Seyferts is surprising low at about 50%. The talk will celebrate the new understanding emerging of the hard X-ray sky and discuss implications for Simbol–X.

31. Perspectives on ground Cerenkov telescopes

Hélène Sol (CNRS, Obs. Paris)

Highlight Talk

Authors: H. Sol

During the last few years, a new branch of astrophysics at very high energy (VHE) has emerged with the success of the current ground-based Cherenkov telescopes. Our cosmos revealed its richness when seen in the TeV gamma-ray range. More than 70 sources of several types have been definitely confirmed as TeV emittors. Atmospheric Cherenkov detectors proved their capability to analyse them in details, get reliable VHE spectra, monitor variable sources and produce light curves down to the minute scale, map the extended sources and even obtain bidimensional spectroscopy. The improved performances of the next generation of detectors as CTA, the Cherenkov Telescope Array, will allow a deep exploration of the extremes of our universe and should significantly contribute to advances in astroparticle physics, astrophysics, and cosmology.

32. Highlight M. Tavani (Highlights from Agile)

Marco Tavani

Highlight Talk

Authors: M. Tavani

N/A

33. Fermi Gamma-ray Space Telescope: Results from the First 4 Months

Peter Michelson (Stanford University)

Higlight Talk

Authors: Peter F. Michelson, on behalf of the Fermi LAT Collaboration and the Fermi Mission team

The Fermi Gamma-ray Space Telescope was launched by NASA on June 11, 2008. Following the successful on-orbit 60 day activation period, the observatory began an extend all-sky survey. The Large Area Telescope, an

imaging wide field-of-view pair conversion telescope that covers the approximate energy range from 20 MeV to more than 300 GeV, observes the entire sky every 3 hours. The Gamma Burst Monitor (GBM), complements the LAT with observations of transients in the range from 10 keV to 25 MeV. Fermi is providing an important window on a wide variety of high-energy phenomena including pulsars, black holes and active galactic nuclei, gamma-ray bursts, cosmic rays and supernovae remnants, and searches for new phenomena such as supersymmetric dark-matter annihilations and relics from the big bang. This talk will describe the Fermi Observatory and summarize observations to date.

Catalogs and Surveys

34. The Palermo Swift-BAT Hard X-ray catalogue: Results after 39 months of sky survey

Giancarlo Cusumano (IASFPa-INAF)

Oral

Authors: Cusumano Giancarlo et al.

We present the Palermo Swift-BAT hard X-ray catalogue obtained from the analysis of the first 39 months of the Swift mission. We have developed a dedicated software to perform data reduction, mosaicking and source detection on the BAT survey data. We analyzed our dataset in three energy bands (14-150 keV, 14-30 keV, 14-70 keV), obtaining a list of 967 detections above a significance threshold of 4.8 standard deviations. The identification of the source counterparts was pursued using three strategies: cross-correlation with published hard X-ray catalogues, analysis of field observations of soft X-ray instruments, cross-correlation with the Simbad databases.
The survey covers 90% of the sky down to a flux limit of < 2.5*10^-11 erg/cm/cm/s in the 14-150 keV band and 50% of the sky at down to a flux limit of < 1.8*10^-11 erg/cm/cm/s. We derived a catalogue of 745 identified sources, of which 64% are extragalactic, 28% are Galactic objecs, 8% are already known X-ray or gamma ray emitters.

35. Extragalactic hard X-ray surveys: From INTEGRAL to Simbol–X

Stéphane Paltani (ISDC/Geneva Observatory)

Oral

Authors: Stéphane Paltani (ISDC), Thierry J.-L.Courvoisier (ISDC), Tom Dwelly (Southampton), Ian M. Mchardy (Southampton), Roland Walter (ISDC)

In spite of their low sensitivities, extragalactic hard X-ray surveys play an important role in the understanding of the accretion phenomenon, because of their ability to study the AGN population with much smaller bias against absorption. We shall review the latest results of these surveys, with an emphasis on the constraint from the cosmic X-ray background. We shall present in particular the results from the deepest extragalactic hard X-ray survey that we performed with INTEGRAL on the 3C 273/Coma region, including Chandra and Swift/XRT follow-up observations, as well as the prospects for hard X-ray surveys at the end of the INTEGRAL mission. Finally we shall evaluate the unique contribution of Simbol–X by exploiting serendipitously observed fields around extragalactic targets.

36. The extragalactic hard X-ray sky as painted by INTEGRAL

Alessandra De Rosa (INAF/IASF-Roma)

Oral

Authors: Alessandra De Rosa on behalf of the INTEGRAL/AGN survey team

The INTEGRAL/IBIS is surveying a large fraction of the sky above 20 keV with a sensitivity larger than a few mCrab, discovering a number of new extragalactic sources many of which now identified as nearby AGN.

We have combined INTEGRAL data with 2-10 keV information (XMM, Chandra, Swift, archival ASCA and BeppoSAX data) to probe the broad-band spectral properties of different classes of AGN: type 1/2 Seyfert galaxies, radio-galaxies, NLSy1, quasar.
Our complete (20-40 keV) sample of AGN contains a number of type 2 Seyfert galaxies that are representative of the population of absorbed AGN selected in hard X-ray. The high quality of data allow us a detailed study of the intrinsic and reflected continuum components. Our analysis shows that, at the limiting flux of the INTEGRAL AGN catalogue, the fraction of obscured AGN is in good agreement with that expected by the CXRB synthesis model. The INTEGRAL results represent the hard X-ray preview of the sky that Simbol–X will observe with higher angular resolution and deeper sensitivity.

37. Synergies between Simbol–X and Herschel/ALMA

Roberto Maiolino (INAF - Observ. Rome)

Invited Talk

Authors: Roberto Maiolino

I will give an overview on the expected synergies between Simbol–X and far-IR/mm observing facilities that will be available in the next decade, and in particular ALMA and the Herschel Space Observatory. I will discuss the expected contribution of these synergies to our understanding of the co-evolution of galaxies and supermassive black holes.

38. The resolved XRB fraction as a function of energy and the emerging population of obscured AGN

Paolo Tozzi, (INAF – OA Trieste)

Poster

Authors: Paolo Tozzi and the CDFs team

We recompute the resolved fraction of the XRB as a function of energy in the Chandra Deep Field South and North. Since obscured sources have a much smaller chance to be detected in X-ray deep surveys due to their spectral shape, their contribution must be properly weighted according to their spectra. With this procedure, we find that the fraction of the resolved XRB contributed by AGN is not decreasing at high energies as rapidly as shown by Worsley et al. (2005). We discuss the implications for the population of obscured AGN to be discovered in future hard X-ray surveys.

39. CAIXA: a Catalogue of AGN In the XMM-Newton Archive

Stefano Bianchi (Universita' degli Studi di Roma TRE)

Poster

Authors: Stefano Bianchi, Nuria Fonseca Bonilla, Matteo Guainazzi, Giorgio Matt, Gabriele Ponti

We present CAIXA, a Catalogue of AGN In the XMM-Newton Archive. It consists of all the radio-quiet X-ray unobscured Active Galactic Nuclei (AGN) observed by XMM-Newton} in targeted observations, whose data are public as of March 2007. With its 156 sources, this is the largest catalogue of high signal-to-noise X-ray spectra of AGN. All the EPIC pn spectra of the sources in CAIXA were extracted homogeneously and a baseline model was applied in order to derive their basic X-ray properties. These data are complemented by multiwavelength data found in the literature: Black Hole masses, Full Width Half Maximum (FWHM) of Hbeta, radio and optical fluxes. Timing analysis was also performed on a sub-catalogue of 96 sources. A systematic search for correlations between the X-ray spectral properties, the excess variance and the multiwavelength data was performed for the sources in CAIXA. Future applications with Simbol–X will also be discussed.

40. Large Scale Structures in the GOODS-South Field up to z ~ 2.5

Dario Trevese (Universita' di Roma "La Sapienza")

Poster

Authors: D. Trevese, M. Cstellano, S. Salimbeni, L.Pentericci, F. Fiore

We present a catalogue of overdensities of the galaxy distribution, detected in the GOODS-South field up to z=2.5. We found various density peaks belonging to large structures diffused on diffused over the entire field and we analysed their optical and X-ray properties from the multiwavelenght GOODS-MUSIC catalogue and the Chandra 2Ms exposure respectively. A group at z~1 can be associated to an extended X-ray source in the CDFS catalogue, while for the other three groups we compute 3-sigma upper limits on the X-ray emission. The two most massive clusters (M_200 >~ 10^14 M_sun) have limits on their X-ray emission significantly lower than expected from their optical properties suggesting that they are either non virialised or gas poor. The segregation of red galaxies with density is stronger at low redshift and high luminosities while it gets much weaker for increasing z, disapperaring at z>1.5. The slope of the colour-magnitude relation for early type galaxies in our clusters does not show significative evolution with z. We also find evidence that galaxies belonging to these structures are more massive than galaxies located in low density regions.

Accretion and jets (I) :AGNs

41. Blazars in hard X-rays

Gabriele Ghisellini (INAF - OA Brera)

Invited Talk

Authors: Gabriele Ghisellini

I will discuss how deep observations in the X-ray band, possible with Simbol–X, will help to understand the physics of relativistic jets.

42. Study of the variability of the reflection component in Seyfert 1 galaxies : connecting the Fe K variability with the Compton hump

Gabriele Ponti (Laboratoire APC, Paris, France)

Oral

Authors: Ponti, G.

The presence of broad Fe lines in the spectra of Seyfert galaxies is still nowadays highly debated because the different absorption/emission models are degenerate. Spectral variability studies have the potential to break this degeneracy. I will first present the results of the Fe K band spectral variability of the brightest type 1 Seyfert galaxies, (obtained thanks to long XMM-Newton exposures). Then I will show the potential of Simbol–X in measuring not only the Fe K variability, but also the associated continuum reflection variability.

43. Compton reflection in AGN with Simbol–X

Volker Beckmann (ISDC)

Oral

Authors: V. Beckmann, T.J.-L. Courvoisier, N. Gehrels, P. Lubinski, P.-O. Petrucci, C.R. Shrader, S. Soldi

AGN exhibit complex hard X-ray spectra. Our current understanding is that the emission is dominated by inverse Compton processes which take place in the corona above the accretion disk, and that absorption and reflection in a distant absorber play a major role. These processes can be directly observed through the shape of

the continuum, the Compton reflection hump around 30 keV, and the iron fluorescence line at 6.4 keV. We will demonstrate the capabilities of Simbol–X to constrain complex models for cases like MCG 05-23-016, NGC 4151, and NGC 2110 in short (10 ksec) observations. We compare the simulations with recent observations on these sources by INTEGRAL, Swift and Suzaku. Constraining reflection models for AGN with Simbol–X will help us to get a clear view of the processes and geometry near to the central engine in AGN.

44. Cloudy skies over AGNs : observations with Simbol–X

Marco Salvati (INAF - Osservatorio di Arcetri)

Oral

Authors: M. Salvati, G. Risaliti

Recent time-resolved spectroscopic X-ray studies of bright obscured AGNs show that column density variability on time scales of hours/days may be common, at least for sources with nH>10^{23} cm^{-2}. This opens new oppurtunities in the analysis of the structure of the circumnuclear medium and of the X-ray source: resolving the variations due to single clouds covering/uncovering the X-ray source provides tight constraints on the source size, the clouds size and distance, and their average number, density and column density. We show how Simbol–X will provide a breakthrough in this field, thanks to its broad band coverage, allowing (a) to precisely disentangle the continuum and nH variations, and (2) to extend the nH variability analysis to column densities >10^{24} cm^{-2}.

45. A Multiwavelength Campaign on SGR A*

Guillaume Trap (CEA Saclay & APC Paris)

Oral

Authors: G.Trap, A.Goldwurm, R.Terrier, E.Pantin, G.Bélanger, D.Porquet,
K.Dodds-Eden and ESO GCLP Members

The center of our galaxy is a nest of compact objects. The most compact of all--Sagittarius A*, a supermassive black hole of about 3 million solar masses--has been the target of a new broad band multiwavelength campaign in early april 2007. This campaign rallied space and ground telescopes from radio to gamma-rays for a week. An exceptionnally bright flare from the immediate vicinity of the black hole has been recorded simultaneously by XMM-Newton and VLT/NACO. It is the first time that such an event benefited from large coverage, namely in Gamma-rays (INTEGRAL), X-rays (XMM-Newton), Near Infrared (VLT/NACO) and Mid Infrared (VLT/VISIR). I will present how our broad spectral measurements challenge the physical models invoked to explain Sgr A*'s spectral energy distribution and light curve, with a particular emphasis on synchrotron self compton emission processes.

46. Timing Analysis in the Low Frequency, Low Signal-to-Noise Regime with an Application to Sgr A*

Guillaume Belanger (ESA, Madrid)

Poster

Authors: Guillaume Belanger

X-ray timing analysis is generally done in application to either X-ray binaries or AGNs. In the former, the periodic or quasi-periodic signals are generally expected at high frequencies, whereas in the latter, they are expected at lower frequencies, but nonetheless well inside the range of testable frequencies given the long observation times. How can we handle cases where the signal is not only weak, but also near the low frequency end of the range of frequencies we have access to? In addition, the noise properties of X-ray light curves from X-ray binaries and AGNs alike most often conform to what is referred to as "red noise". Therefore, we need to have a way to take this into account when we detect a signal and intend to assign a reliable statistical probability to it. These are the topics that I will discuss during this presentation, before presenting a thorough and complete method for carrying out such an analysis, with application to Sgr A*.

47. The Galactic Centre view with Simbol–X

Lorenzo Raimondi (INAF-IASF-Bologna)

Poster

Authors: L. Raimondi, G. Malaguti, L. Angelini, M. Cappi, P. Grandi, G.G.C. Palumbo

The nature of the hard X-ray emission above 3 keV of the Galactic Centre is still source of controversy. Recent observations with Chandra are consistent with either a population of discrete sources or with a diffuse non thermal emission or most likely a combination of the two.
The Simbol–X mission will be equipped with a grazing incident telescope imaging up to ~80 keV, providing an improvement of three order of magnitude in sensitivity and angular resolution compared with the instruments that have operated so far above 10 keV. This capability will enable to directly disentangle between the discrete source versus the diffuse emission scenario.
We present here Simbol–X simulations of the Galactic Centre where the input model includes a list of both diffuse and point sources but also an unresolved emission using the input spectrum observed with presently operating X-ray telescopes.

48. The Simbol–X view of radio galaxies lobes

Eleonora Torresi (INAF-IASF Bologna)

Poster

Authors: G. Migliori, E.Torresi, P.Grandi, L.Angelini, L.Raimondi, G.G.C. Palumbo

The lobes of radio galaxies are strong radio emitters. Recent Chandra and XMM-Newton observations have shown that lobes can be X-ray emitters via Inverse Compton (IC) scattering. Combining radio and X-ray observations, the energy densities of particles and magnetic fields in the lobes can be constrained. An accurate estimate of the lobe energetic is important both to study the total amount of kinetic energy supplied by the central engine, and to investigate the interactions of the expanding radio source in the different environments. We show here that Simbol–X will represent a crucial progress in these kind of studies. The low and stable background ensures the detection and spectral study of even faint X-ray counterparts of radio lobes. The low energy threshold together with the hard X-ray coverage above 10 keV are determinant to disentagle the non-thermal IC emission from the possible contamination of hot gas X-ray thermal emission, often associated with the expanding radio sources.

49. Variability of FeK complex features in radio-quiet AGNs with Simbol–X

Barbara de Marco (SISSA/ISAS Trieste)

Poster

Authors: B. de Marco

FeK line complex variability studies are of the utmost importance in order to understand the dynamics and geometry of the innermost accretion flow in AGNs. We present the systematic study of a flux-limited sample of radio quiet AGNs, observed with XMM-Newton, focused on the search for variable FeK emission features. In order to follow the features temporal behaviour we mapped the emission in excess of the continuum in the time-energy plane, between 4-9 keV. Using Monte Carlo simulations we obtained an estimation of the variability significance. Based on the results obtained, we explore the improvements that the high-energy astrophysics mission Simbol–X will give to this kind of studies.

50. Radio Galaxies with Simbol–X

Paola Grandi (INAF IASFBO)

Poster

Authors: Paola Grandi

The black holes in the hearts of bright elliptical galaxies are commonly observed to be associated with powerful relativistic jets. The mechanism by which such jets form and the efficiency with which the energy associated with material entering the accretion radius is converted into jet power at much smaller radii remains the subject of much debate. Another still open question involves the interplay between the relativistic jet and the interstellar/intergalactic medium within the relativistic plasma deposits most of its power.
Such knowledge is important for understanding the nature of the accretion process, galaxy formation and the growth of supermassive black holes. Simbol–X can play a fundamental role in exploring the link between accretion and relativistic outflow and the interaction of the jet with the surrounding environment.

51. Blazar science from INTEGRAL and Swift to Simbol–X

Luigi Foschini (INAF/IASF-Bologna)
Poster

Authors: L. Foschini

I review the advancements in blazar science made possible in the past years by INTEGRAL and Swift and I outline the possibilities that can be opened with Simbol–X.

52. Exploring the physics of accreting black holes with Simbol–X

Rene Goosmann (Observatoire Astronomique de Strasbourg)
Poster

Authors: Rene W. Goosmann

A major scientific goal of the Simbol–X mission is to improve our knowledge of black hole accretion. By opening up the X-ray window above 10 keV with unprecedented sensitivity and resolution we obtain new constraints on the X-ray spectral and variability properties of active galactic nuclei and Galactic black hole candidates. To interpret the future data, detailed modeling of the dynamics and of the radiation processes in the black hole vicinity is required. Close to the event horizon relativistic effects have to be taken into account, which in reverse allow to determine the space-time structure from the profile and variability of the iron K line complex and the Compton hump. Shifted emission and absorption lines tell us about the structure, dynamics, and chemical composition of outflows being linked to the accretion process and efficiency. Using simulated spectral and variability data that is based on detailed modeling, I show how Simbol–X will enable us to conclude on global parameters of accreting black holes, such as their mass and spin or the accretion and outflow rate.

53. The multi-component X-ray emission of 3C 273

Simona Soldi (ISDC)
Poster

Authors: S. Soldi, M. Tuerler, S. Paltani, T. Courvoisier

3C 273 is the brightest quasar in the sky and among the most extensively observed and studied AGN, therefore one of the most suitable targets for a long-term, multi-frequency study.
Using radio to gamma-ray data covering up to 40 years of observations, we study the properties of the variability across the 3C 273 spectrum and search for possible connections between the emission at different energies.
The superposition of a thermal Comptonization component, similar to that observed in Seyfert galaxies, and of a non-thermal component, related to the jet emission, seems to explain some of the spectral and timing properties of the X-ray emission of 3C 273. Yet, during some observations this dichotomy has not been observed and the variability properties could also be consistent with a single-component scenario, characterized by two parameters varying independently.
In order to understand the nature of the X-ray emission in 3C 273, a series of observations up to 80-100 keV, possibly catching the source in different flux states, are essential. Simbol–X will be able to study the emission of 3C 273 in the broad 0.5-80 keV band with high sensitivity, allowing us to disentangle the emission from different spectral components, with 10-20 ks long observations.

54. Time dependent modelisation of BL-Lacs

Timothé Boutelier (LAOG)

Poster

Authors: Boutelier Timothé, Henri Gilles, Petrucci Pierre-Olivier

Broad band radio to gamma-ray emission of Blazar is commonly believed to originate from a relativistic jet pointing in our direction. We present a new time-dependent stratified jet model, where ultra-relativistic leptons are injected at the base of the jet and propagate along the jet structure. This model reproduces the entire spectral energy distribution of Blazar together with the rapid gamma-ray variability. It has been applied successfully to the dramatic TeV flaring episod of PKS 2155 in summer 2006, reproducing simultaneously the average broad band spectrum of this source as well as the TeV spectra. We success also to fit simultaneous X-ray and TeV light curve of the flare with bulk Lorentz factor lower than 15! We show how such a model helps to lower the constrains on the jet Lorentz factor, and propose the pair creation process as a likely mechanism to interpret the observed variability. Sensitive instruments in all wavelength are of crucial importance to improve our understanding of this class of objects and, through simulations, we show that, in the X-ray range, Simbol X will be of primary importance.

Accretion and jets (II): binaries & ULX

55. Relativistic Jets on all scales in accreting black holes

Stéphane Corbel (CEA Saclay)

Invited Talk

Authors: S. Corbel

In the last several years, multiwavelength observations of accreting black holes have allowed a general characterisation of black holes properties as they evolve along the course of their outburst cycle. In this talk, I will review these generic properties and I will show how these new developments have change our perception of emission processes in accreting black holes. In addition, I will highlight some contributions from Simbol-X for a better understanding of the accretion - ejection coupling in accreting sources.

56. Is the ejection of the corona a common phenomenon in microquasars?

Lionel Prat (CEA, Saclay)

Oral

Authors: Lionel Prat, Jérôme Rodriguez

The onset of most microquasar outbursts is characterized by a state transition between a Low/Hard State (LHS) and a High/Soft State (HSS). Besides drastic spectral and timing changes, this transition often shows a discrete ejection event detectable in the radio range. However, the exact nature of the ejected material and the mechanisms that give birth to these phenomena are yet to be unraveled. Recent simultaneous radio and X-ray observations on several sources point to a coronal nature of the ejected material. In the first two sources, XTE J1550-564 and GRS 1915+105, the hard X-ray tail, usually attributed to an inverse Compton effect, disappears just before an ejection is detected at radio wavelengths. We interpret this behaviour as evidence of the disappearance of the corona, which is ejected under the form of blobs. In the cases of XTE J1748-288 and the 2002 outburst of GX 339-4, the first radio detection occurs after a decrease of the disc flux, which may indicate that the radio events are initiated by the disc. The peak of the radio flare occurs several day after, and in particular after a large decrease of the coronal flux. Thus, a total of 4 microquasars point in the direction of an ejection of the corona, feature that is yet to be confirmed (or infirmed) in the case of other available sources.

57. About a unified view of the accretion-ejection mechanisms in microquasars and how it can be tested with Simbol–X

Pierre-Olivier Petrucci (LAOG, France)

Oral

Authors : P.-O. Petrucci

We will present the most recent developments of the unified model we proposed since a few years to explain the spectral states of BHbinaries as well as their spectral evolution during outbursts. We will present the main dynamical components of this model, the corresponding SEDs, and their comparison to real data, as well as the application of the model to the hysteresis behavior of X-ray binaries. This theoretical framework will allow us to discuss the progresses we can expect in our understanding of this kind of objects from Simbol–X observations.

58. The importance of Simbol–X for our understanding of ULXs

Manfred W. Pakull (Obs. Strasbourg)

Oral

Authors : Manfred W. Pakull

Despite a large body of available Chandra and XMM observations, recent progress in our understanding of ULXs has largely come from optical and radio studies. Among other important clues about their nature these complementary studies have revealed the presence of strong outflow/jets with mechanical powers that are comparable to their 'ultraluminous' X-ray output.
In the framework of various galactic black hole models the interpretation of 0.3-10 keV ULX spectra have largely remained ambiguous, not least because expected spectral breaks appear near or beyond the observed X-ray range. Here we will outline how the hard X-ray sensitivity of Simbol–X will help to distinguish between various ULX models, including intermediate mass black holes, slim disks, and absorption/emission in fast ionized outflows.

59. Hard X-rays from Accreting Black Holes

Andy Fabian (Univ. Of Cambridge)

Invited Talk

Authors: A.C. Fabian

The hard X-ray emission from accreting black holes, both stellar mass and supermassive, will be discussed. Attention will be paid to high energy cutoffs, reflection features and the integrated hard spectrum.

60. Black-Hole Binaries : Life Begins at 40 keV

Tomaso Belloni (INAF - OA Brera)

Oral

Authors: Tomaso Belloni (INAF-OAB)

It is well established that, in their hard states, the peak of the emission of bright black-hole binaries is around 100 keV, while soft states are dominated by lower-energy thermal photons, with only a smaller contribution by a hard component. The nature of the hard components is not fully understood, but it is clear that it is related to the presence/absence of relativistic jets. I will outline the current status of our knowledge and will show that despite the relatively low upper energy bound of Simbol–X, its characteristics make it an important mission for the study of broad-band emission from black-hole binaries.

61. Spectral states of black hole binaries

Julien Malzac (CESR, Université de Toulouse, CNRS)

Oral

Authors: Julien Malzac

Emphasising the exciting prospects for Simbol–X, I will discuss the dramatically different X-ray spectral shapes observed in the Low Hard State (LHS: dominated by thermal comptonisation) and the High Soft State (HSS: dominated by the accretion disc thermal emission and non-thermal comptonisation in the corona) of Cygnus X-1 and other black hole binaries. Typical LHS and HSS spectra are then modelled using a new code accounting for the so-called synchrotron boiler effect. These numerical simulations when compared to the data allow us to constrain the magnetic field and temperature of the hot protons in the corona. For the hard state of Cygnus X-1, we find a magnetic field below equipartition with radiation, suggesting that the corona is not powered through magnetic field dissipation (as assumed in most accretion disc corona models). On the other hand, our results also point toward proton temperatures that are substantially lower than typical temperatures of the ADAF models. Finally, I show that in both spectral states the magnetised corona could be powered essentially through power-law acceleration of non-thermal electrons, which are then partly thermalised by the synchrotron boiler. This suggests that, contrary to current beliefs, the corona of the HSS and that of the LHS could be of a very similar nature. The differences between the LHS and HSS coronal spectra would then be predominantly caused by the strong disc soft cooling emission which is present in the HSS and absent in the LHS.

62. Observing cataclysmic variables in the Simbol–X energy band

Maurizio Falanga (CEA-Saclay)

Oral

Authors: M. Falanga

The majority of cataclysmic variables observed in the hard X-ray energy band are intermediate polars where the magnetic field is strong enough to channel the accreting matter to the magnetic poles of the white dwarf. A shock above the stellar surface heats the gas to rather high temperatures (10--70 keV). The post-shock region cools mostly via optically thin bremsstrahlung.
In the strongly magnetized (B ≥ 107 G) polar systems, cyclotron cooling is an important mechanism to suppress the bremsstrahlung high temperature emission whilst it should be negligible among IPs. This could explain why most hard X-ray CVs are IPs. However, there is so far no clear explanation of the high temperature achieved in some cases and this remains an open problem until a detailed characterization of each of these high energy CVs is obtained. Simbol–X will be important to further study CV at high energy.

63. Identification of X-ray sources in Galactic globular clusters: Simbol–X simulations

Mathieu Servillat (CESR)

Oral

Authors: Servillat M.

Globular clusters are old, dense stellar systems which harbour an excess of X-ray sources compared to the number of X-ray sources in the Galactic plane. These X-ray sources, which are mainly close binaries, can be produced through dynamical encounters in the dense core of globular clusters, and are thus intimely linked to their dynamical evolution. A multiwavelength study is needed in order to identify the X-ray sources which are faint and have generally unconstrained X-ray spectra.
I will present XMM-Newton, Chandra and HST observations of the very dense Galactic globular cluster NGC 2808. From statistical analysis, 16 X-ray sources are very likely to be linked to NGC 2808. We found one likely neutron star low-mass X-ray binary in quiescence and 8 cataclysmic variable candidates in the core of NGC 2808, of which a majority could be magnetic.
Simulations of Simbol–X observations indicate that the angular resolution is sufficient to study X-ray sources in the core of close, less dense globular clusters, such as M 22. The sensitivity of Simbol–X in an extended energy

band up to 80~keV will allow to discriminate between hard X-ray sources (such as magnetic cataclysmic variables and millisecond pulsars) and soft X-ray sources (such as chromospherically active binaries).

64. Restablished accretion in post-outburst classical novae revealed by X-rays

Margarita Hernanz (Institut de Ciencies de l'Espai CSIC-IEEC)
Oral

Authors: M. Hernanz, C. Ferri, G. Sala

Classical novae are explosions on accreting white dwarfs in cataclysmic variables; a hydrogen thermonuclear runaway on top of the white dwarf is responsible for the outburst. X-rays provide a unique way to study the turn-off of the burning (super soft X-rays emitted by the hot WD photosphere), but also to understand how accretion is established again in the binary system. Observations with XMM-Newton of some post-outburst novae have revealed such a process, but a coverage up to larger energies -as Simbol–X will provide- is fundamental to well understand the characteristics of the binary system (e.g., magnetic field, geometry of the accretion flow) and of the nova ejecta (e.g. chemical composition, density). We will present a summary of our results up to now and prospects for Simbol–X mission.

65. The contribution of Simbol–X to the understanding of Ultraluminous X-ray Sources

Luca Zampieri (INAF-Astronomical Observatory of Padova)
Poster

Authors: L. Zampieri

Ultraluminous X-ray Sources (ULXs) represent one of the most intriguing challenges of modern Astrophysics. Several facts indicate that they are black hole X-ray binaries with a young, massive companion. Yet, the most fundamental questions on ULXs remain still unanswered: Do they contain stellar (~10 solar masses) or intermediate mass (100-1000 solar masses) black holes? How do they form? Simbol–X will have the capability to explore for the first time the spectral behavior of ULXs above 10 keV, opening a new window on the study of these enigmatic sources. We will discuss what we can learn on the physics of ULXs using Simbol–X observations.

66. NGC 1313 X-2 : ULX in a 20 Myr old star cluster embedded in a shock-ionized nebula

Fabien Grisé (Obs. de Strasbourg)
Poster

Authors: Fabien Grisé, Manfred Pakull, Roberto Soria, Christian Motch

Complementary to X-ray observations, optical studies can supply important information about the environment of ULXs and provide major clues for understanding the nature of these systems.
Here we present our study of the local stellar population and nebula in the nearby galaxy NGC 1313 in which ULX-2 is embedded. The source was observed with ESO-VLT and HST which has allowed to resolve individual stars. The ULX belongs to a young cluster in a low-metallicity environment with an age of some 20 Myr, i.e. containing only stars up to 10 M_sun since more massive stars have already exploded as supernovae.
The optical counterpart appears to have the same optical colors as the surrounding stellar population, leading to a donor mass of about 10 M_sun. We discuss a likely contribution from the X-ray heated accretion disk which is consistent with the presence of HeII4686 emission. We detect optical variability of ~0.2 mag amplitude which however does not appear to be consistent with periodic ellipsoidal variations.
Finally, the nebula surrounding the ULX is mainly consistent with shock ionization although the west part shows a more complicated structure with certainly another ionization process acting.

67. X-ray binaries as templates for accretion

Elmar Koerding (Paris Diderot / SAp CEA/Saclay)

Poster

Authors: E. Koerding, R. Dunn

Black hole X-ray binaries are ideal candidates for the study of accretion states and their evolution over time. The X-ray binary outburst timescale is of the order of a few months, which allows for easy and detailed monitoring at all stages. In Active Galactic Nuclei (AGN) this timescale increases to values larger than several million years making it impossible to observe changes in a single object during such an outburst. On the other hand, an eruption of a cataclysmic variable is usually so short (only a few days) that it is hard to observe state changes in detail. Thus, XRBs may be the best templates for the properties of accretion in general. I will present connections between XRBs, AGN and other accreting objects that allow us to scale the measured properties of XRBs to the other source classes. I will present a study of all XRBs were a full outburst is observed with RXTE and will discuss the improvements Simbol–X will make in this area.

68. Class transition of GRS 1915+105

Asit K. Choudhury (Indian Centre for Spaces Physics, Kolkata)

Poster

Authors: Asit K. Choudhury

The microquasar GRS 1915+105 exhibits at least 13 distinct classes of light curves. So there must be a time when one class of light curve is transferred to another class. While RXTE satellite has pointed to this object about a thousand times, it has not been able to pinpoint exactly how and when a class transition actually takes place. We show that Indian Satellite IXAE observed such class transitions several times. We also show that the source probably had 'premonition' about the class-transition about a few hundred seconds prior to the observation. . It is also observed that the QPO frequencies are changing during the transitions. Assuming that the transitions are caused by variations in the accretion rates, implies that a significant fraction of the matter must be nearly freely falling in order to have such transitions.

69. The X-ray and radio states of Cyg X-3 - classification and long-term correlations

Anna Szostek, (Laboratoire d'Astrophysique de Grenoble)

Poster

Authors: Anna Szostek

I will present detailed classification of the X-ray states of Cyg X-3 based on the spectral shape and a new classification of the radio states based on the long-term correlated behaviour of the radio and soft X-ray light curves. Except for the effect of strong absorption and the energy of the high-energy break in the hard state, the X-ray spectral states of Cyg X-3 closely correspond to the canonical X-ray states of black-hole binaries. Also, the radio X-ray correlation closely corresponds to that found in black-hole binaries, but it significantly differs from that in neutron-star binaries. At the end, I will present spectra as predicted for Simbol–X and discuss possible implications for the future studies of Cyg X-3.

70. Broad-band parallel studies of 3 famous microquasars: Cygnus X-1, GRS 1915+105 and XTE J1818-245

Marion Cadolle Bel (ESA/ESAC, Madrid)

Poster

Authors: M. Cadolle Bel, L. Prat, J. Rodriguez, M. Ribo, D. Hannikainen, P. D'avanzo, S. Campana, E. Kuulkers, S. Corbel, S. Chaty, J. Zurita-Heras, A. Goldwurm, P. Goldoni, J. Malzac, M. Tagger, on behalf of a larger collaboration

In the light of recent multiwavelength observations obtained with INTEGRAL, RXTE, MAGIC and ground-based instruments (in radio, NIR and optical), I will present some progress that has been made in the understanding of these interesting X-ray binary sources, and what we can learn from them and further observations with Simbol–X. Broad-band spectra showing spectral transitions and fast time-variability properties were derived on these sources together with radio, (N)IR and optical data. Spectral energy distributions are built and some constraints derived. Focusing on Cygnus X-1, that was seen by INTEGRAL during a bright event that occurred in 2006 September simultaneously with a detection at 0.1-1 TeV energies by the MAGIC telescope, I will discuss a similar recent hard flare seen on 2008 May 18. In parallel, I will summarize the results other monitoring multiwavelength campaigns on XTE J1818-245 and GRS 1915+105: for the latter, several discrete ejections occurred (seen for the 1st time in the lambda class!) and the trigger of the ejection was identified, while a possible relation was found between the amplitude of the radio flare and the duration of the dip. A general "hand-made" scenario is proposed for the microquasar's behavior and their evolution in the Hardness Intensity Diagram.

71. Probing compact jet emission in GX 339-4

Mickael Coriat (CEA Saclay)

Poster

Authors: M. Coriat, S. Corbel, M. Buxton, E. Körding, J. Tomsick, S. Markoff, C. Baylin

GX 339-4 has been one of the key sources for unraveling the accretion ejection coupling in accreting stellar mass black holes. After a long period of quiescence between 1999 and 2002, GX 339-4 underwent a series of 4 outbursts that have been intensively observed by many ground based observatories (radio/infrared/optical) and satellites (RXTE/Integral). In this talk, I will present some specific results of these broad band observational campaigns, focusing on the hard state of GX 339-4: the evolution of the radio/X-ray and OIR/X-ray flux correlations over several outbursts, the hysteresis cycles in GX 339-4, and the evolution of the compact jet spectrum during outbursts. I will provide new constraints on the role/interplay of the various emission components in the broad band spectra of GX 339-4, i.e., the hard X-ray comptonization component, the accretion disk thermal emission and the compact jet. Finally, I will present some centrals questions in this field of research, that Symbol–X will be able to address.

72. Gravitational Radiation in X-ray Binary Stars

Kadri Yakut (IoA, University of Cambridge)

Poster

Authors: K.Yakut

Angular momentum loss (AML) mechanisms and dynamical evolution owing to magnetic braking and gravitational radiation in X-ray relativistic binary stars (RBS) are studied.
We have calculated and compared AML time scales for the X-ray RBS with non-degenerate components and double degenerate (DD) systems.

73. Exploring the hard and soft X-ray emission from magnetic CVs

Domitilla de Martino (INAF Capodimonte Observatory Naples)

Poster

Authors: D. de Martino et al.

Magnetic Cataclysmic Variables are nowdays rapidly increasing in number thanks to the many new detections in hard X-ray surveys, suggesting that these systems could be important contributors to the hard X-ray sky. Most of them are found to belong to the Intermediate Polar class with a handful of desynchronized Polars. The former group is thought to host weakly magnetized accreting white dwarfs. Many Intermediate Polars were recently discovered to also exhibit a soft X-ray component, that covers a wide range of temperatures but only partially overlapping that of the strongly magnetized Polar-type systems. A characterization of hard and soft X-ray emission with high sensitive broad-band facilities like Simbol–X will be crucial to understand the role of

fundamental parameters of the accreting primaries with important feedbacks in the study of galactic populations of X-ray sources as well as of the evolution of Cataclysmic Variables.

74. Period Variation Study in AM Her

Kadri Yakut (IoA, University of Cambridge)

Poster

Authors: B.Kalomeni, K.Yakut

In this study, five years ground based optic variability of magnetic cataclysmic variable AM Her, has been studied. The obtained times of minimum light are combined with those given in the literature and the (O--C) curve is constructed. Studying the (O--C) diagram we estimate a possible increase in period, $\frac{dP}{dt}=7.5(1.2)\times10^{-9}$~d~yr^{-1}, with a mass transfer rate of $\dot M = 8(2)\times10^{-9}$$M_{\odot}$/yr.

75. Searching massive white dwarfs

Marina Orio (INAF Padova)

Poster

Authors: M. Orio

Many classical and recurrent novae are detectable X-ray sources at quiescence because of ongoing accretion onto the white dwarf. The shock temperature has turned out in several cases to be so high that it is outside the maximum range of current imaging telescopes and it cannot be exactly measured. Simbol–X will allow us to measure the maximum temperature in the accretion flow, which is dependent on the gravitational potential of the white dwarf and therefore on its mass. We will thus be able to obtain a mass estimate and verify the indications we have that the white dwarf in some of these systems is near the
Chandrasekhar value.

CXB, Obscured accretion

76. The role of obscured AGN activity in the universe

Kirpal Nandra (Imperial College London)

Invited Talk

Authors: K. Nandra

We do not currently have a complete census of AGN, and hence we only have a partial view of the role of accretion activity in the universe. I will review our current understanding of the AGN population based on deep multiwavelength surveys, with a look forward to how Simbol–X might impact on the subject.

77. Cosmological Evolution of AGNs: Predictions from Hierarchical Models of Galaxy Formation

Nicola Menci (INAF - Osservatorio Astronomico di Roma)

Oral

Authors: N. Menci

We will present predictions for the cosmological evolution of AGNs from semi-analytic modeling of galaxy formation. The predictions for the cosmic density of AGNs and their luminosity functions at high redshift will be presented. We shall also present specific predictions for the luminosity and redshift dependence of the

obscuration properties of AGNs at high redshifts, along with their dependence on the AGN feedback onto the galactic gas.

78. The Simbol–X view of Compton Thick AGNs

Roberto Della Ceca, (OA Brera)

Oral

Authors: Della Ceca, Caccianiga and Severgnini

We have recently derived the X-ray luminosity function (XLF) of Compton Thick AGNs, through the comparison of an optically selected sample of AGN with an X-ray selected sample. We will compare this XLF with recent estimate of the number density of Compton Thick AGN from other projects and we will use it to constrain the number of Compton thick AGN to be found in the Simbol–X survey(s).

79. A new measurement of the Cosmic X-ray Background spectrum

Alberto Moretti (INAF-OAB , Italy)

Oral

Authors: A. Moretti

We present a new measurement of the Cosmic X-Ray Background (CXRB) in the 1.5-7 keV energy band, performed by exploiting the Swift X-ray telescope (XRT) data archive. While there is a general consensus on the sources from which CXRB originates, and the background paradox can be considered solved, nevertheless the spectrum of the X-ray integrated emission is still very important in the study of the statistical properties of those sources which are too faint be detected individually by currently operating telescopes, as highly absorbed AGNs and very high red-shift quasars. Measurements performed in the soft part of the CXRB spectrum with different instruments in the last years yield a scatter which cannot be entirely explained by differences in absolute calibrations. Swift-XRT archival dataset has two main advantages. Those are the peculiar observational mission strategy, which provides us with a truly random sampling of the X-ray sky and the low level of the instrumental background. Taking advantage of the accurate cross-calibration between the two Swift high energy instruments (XRT and BAT), we produce an analytical description of the CXRB spectrum over a wide (1.5-200 keV) energy band.

80. The infrared/sub-millimeter view of luminous X-ray selected Type 2 quasars

Cristian Vignali (Dipartimento di Astronomia, Universita' di Bologna)

Oral

Authors: C. Vignali, F. Pozzi, J. Fritz, A. Comastri, C. Gruppioni, E. Bellocchi, F. Fiore, M. Brusa, R. Maiolino, M. Mignoli, F. La Franca, L. Pozzetti, G. Zamorani

Over the last decade, X-ray and infrared surveys have offered powerful selection criteria towards a more complete census of the population of luminous, obscured (Type 2) quasars. However, despite many Type 2 quasar candidates have been found, a proper understanding of their broad-band properties is somehow still missing. We present the multi-wavelength properties for a sample of hard X-ray selected Type 2 quasars over the z=0.9-2.1 redshift range using Spitzer observations. For these AGN, estimates on the bolometric luminosities and Eddington ratios are presented and compared to other AGN samples. We will focus on a z=2 X-ray powerful, obscured quasar for which the detection in the far-infrared (Spitzer) and sub-mm (SCUBA) allows us to properly characterize its spectral energy distribution by means an AGN component, dominant in the mid-IR, with an optical depth at 9.7 micron along the line of sight of tau(9.7)=1.0-1.2, and a far-IR starburst component to reproduce the wide bump observed longward of 70 micron. The derived star-formation rate, 1000 solar masses per year, makes this AGN a relevant example of coeval nuclear activity and considerable star formation at high redshift.
Prospects in the quest for and spectral characterization of obscured quasars by the future Herschel and Simbol–X missions will be highlighted.

81. Revealing X-ray obscured quasars in Spitzer sources with extreme mid-IR to optical flux ratios

Enrico Piconcelli (INAF-OA Roma)

Oral

Authors: E. Piconcelli, G. Lanzuisi, F. Fiore

Recent works have suggested that selection criteria based on MIR colors can be used to reveal a population of dust-enshrouded, extremely luminous quasars at z>1. However the X-ray spectral properties of these intriguing sources still remain largely unexplored. We report on an X-ray spectroscopic study of a large sample of very bright mid-IR galaxies with extreme mid-IR to optical flux ratios (MIR/O>2000). The vast majority (95%) of these sources show an absorption column density NH>10e22 cm-2 and, remarkably, we also find that 50% of them can be classified as Type 2 QSOs on the basis of their absorption properties and X-ray luminosity. The application of our MIR/optical photometric selection to a large area survey such as the SWIRE has allowed to efficiently pick up a large sample of high-z sources at the brightest end of the obscured AGN population, which are mostly missed in traditional optical/X-ray surveys performed so far. The existence of this class of highly-obscured quasars at high z may have important implications for the formation and cosmological evolution of accreting SMBHs and their host galaxies. Advances in the understanding the nature of these recently-discovered sources by Simbol–X observations will be also discussed.

82. [HB89] 0102-272: a quasar with an extremely steep soft photon index ?

Thomas Boller (MPE Garching)

Oral

Authors: Th. Boller

I report on a quasar with a steep soft 0.1-2.4 keV X-ray photon index based on ROSAT PSPC observations. [HB89] 0102-272 exhibits a photoni ndex of 6.55+-2.07. A second observation of the object confirms the unusual steep soft X-ray slope with a photon index of 6.40+-2.20. This is the steepest spectral energy distribution in the 0.1-2.4 keV energy bandfrom an extragalactic object reported so far. The limited spectral energy resolution of ROSAT does not allow to constrain other spectral components. I present Simbol–X simulations for several models: a disk black body plus power law fit, a Comptonisation model for the hard component, a smeared absorption model, a disk reflection model, and an ionized absorption model. I show for instance that an ionized absorber in a certain ionization state and column density range flattens the spectrum significantly.

83. The nuclear environment of narrow line radio galaxies with Simbol–X

Eleonora Torresi (INAF-IASF Bologna)

Poster

Authors: E. Torresi, P. Grandi, G. Malaguti, G.G.C. Palumbo

Radio-loud sources have different X-ray properties according to their Fanaroff-Riley (FR) type. In FRI the non-thermal emission from the jet generally dominates the X-ray spectrum and no torus surrounds the central core. On the other hand FRII radio galaxies, in particular Narrow Line Radio Galaxies (NLRG), optically classified as HEG (High Excitation Galaxies), seem to hide very powerful accretion disks. For the latter Chandra and XMM-Newton have provided X-ray spectra similar to Seyfert 2 galaxies at least below 10 keV. HEGs are heavily obscured and present a prominent fluorescent Fe Ka line, with a soft excess which seems to be produced by photo-ionized gas. Our knowledge of NLRGs above 10 keV is very poor, being the previous and current hard X-ray observatories unable to study them in detail. The high sensitivity of Simbol–X will provide for the first time very accurate spectra of a large sample of NLRGs, allowing an unprecedented investigation of the nuclear continuum and the reflection hump (when present) in FRI/FRII galaxies. In this work the capability of Simbol–X in assessing the possible differences between NLRGs and Seyfert 2s, in terms of circumnuclear environments, will be addressed.

84. The IR to X-rays SED of the Type 2 quasar IRAS09104+4109

Giorgio Lanzuisi (INAF-OAR)

Poster

Authors: G. Lanzuisi, E. Piconcelli, F. Fiore, C. Feruglio, R. Maiolino

Constraining the AGN Nh distribution at high column densities and high X-ray luminosites is crucial to determine a reliable L(5.8mu)/L(2-10 keV) luminosity ratio distribution and compare it with the expectations of dust reprocessing models. In this context we present here the IR to X-rays broad band SED of well-known Type 2 quasar IRAS09104+4109. We have recently published the XMM observation of this powerful obscured quasar, suggesting for the first time the Compton-thin nature of its absorber.

85. The Simbol–X perspective on the physics of quasar outflows

Margherita Giustini (University of Bologna, INAF/IASFBO)

Poster

Authors: M. Giustini, M. Cappi, C. Vignali, G.G.C. Palumbo, F. Fiore, G. Malaguti

There is mounting evidence that quasar outflows may play a key role in providing the feedback between AGN/QSOs and their surrounding (and feeding) media, in regulating the central supermassive black hole growth and the galaxy formation and, on larger scales, in shaping the growth of cosmic structures.
The most compelling evidence for the presence of powerful outflows from the inner regions of AGNs is provided by the broad absorption line quasars (BALQSOs).
X-ray observations of BALQSOs are crucial to probe the innermost parts of their outflows, provide clues on the underlying physical mechanisms, and assess the global energetics entrained in the outflow by probing its most extreme (in terms of velocity, ionization state, mass outflow rate) phases.
Simbol–X – with its high effective area in the Fe K energy band and above – will allow the detection and characterization of powerful outflows in low redshift BALQSOs, so helping in quantifying the feedback due to these objects.

Acceleration

86. Observational evidence for efficient particle acceleration by supernova remnants

Jacco Vink (Utrecht University)

Invited Talk

Authors: Jacco Vink

For a long time supernova remnants were regarded to be the best candidate sources for Galactic cosmic rays. However, it is only during the last decade that observational evidence has been found that supernova remnants are indeed capable of acceleration cosmic rays abundantly and to sufficiently high energies.

The observational evidence has mainly come from to wavelength bands: X-rays and TeV gamma-ray. I will give an overview this observational evidence, and discuss some of the uncertainties concerning cosmic ray acceleration by supernova remnants.
Finally, I will discuss what future missions like Simbol X, in conjunction with future ground based observatories will teach us about this topic.

87. The emerging population of Pulsar Wind Nebulae in Hard X-Rays

Fabio Mattana (APC, Paris)

Oral

Authors: Fabio Mattana, Diego Götz, Matthieu Renaud, Régis Terrier, and Maurizio Falanga

Most of the rotational power of isolated pulsars is carried by a magnetized relativistic wind, which manifests itself trough the interaction with the surrounding medium. Although the Pulsar Wind Nebulae (PWNe) arising from this interaction are well observed at radio, X-ray, and TeV wavelengths, so far only the most luminous or nearby are detected
above 10 keV.
The hard X-ray synchrotron emission of PWNe probes more energetic particles than the soft one, hence it is more closely related to the pulsar spin-down. Further, several factors (notably the evolving pulsar rotational power and nebular magnetic field) can lead to a more complex
hard emission with respect to the simple extrapolation of the soft power-law spectra.
The number of hard X-ray PWNe is increasing thanks to the imaging capability of IBIS on board the INTEGRAL satellite, and to the long exposure time accumulated since the launch of the mission. We present the analysis of INTEGRAL data of several PWNe. After comparing their properties with those of the sample of PWNe known in hard-X rays, we
interpret their emission in the framework of an evolving electron energy population. Finally, we discuss some physical insights that can be addressed by Simbol–X observations of Pulsar Wind Nebulae.

88. What can Simbol–X do for gamma-ray binaries?

Benoît Cerutti (LAOG)

Oral

Authors: Benoît Cerutti, Guillaume Dubus, Gilles Henri

Gamma-ray binaries have been uncovered as a new class of galactic objects in the very high energy sky (>100 GeV). The three, perhaps four, systems known today have hard X-ray spectra (photon index ~1.5), extended radio emission and a high luminosity in gamma-rays. Recent monitoring campaigns of LS I+61°303 in X-rays have confirmed variability in these systems and revealed a spectral hardening with increasing flux. In the pulsar model, the collision between the winds of the massive star and a young pulsar accounts for the main spectral and temporal features. Hard persistent X-ray emission is expected to extend well beyond 10 keV. We will explain how Simbol–X will constrain the existing models in connection with Fermi Space Telescope measurements. Because of its unprecedented sensitivity in hard X-rays, Simbol–X will also play a major role in the discovery of new gamma-ray binaries, giving new insights into the evolution of compact binaries.

89. X-ray studies of unidentified Galactic TeV gamma-ray sources

Gerd Pühlhofer (IAA Tübingen)

Oral

Authors: G. Pühlhofer

Many of the recently discovered Galactic TeV sources remain unidentified to date. An important question is their contribution to the overall Galactic cosmic ray particle flux up to PeV energies. A large fraction of the sources is likely associated with relic pulsar wind nebula (PWN) systems. One key question here is the maximum energy (beyond TeV) attained in the compact PWNe. Hard X-ray emission can trace those particles, but current non-focusing X-ray instruments above 10 keV are in most cases not able to deconvolve the hard pulsar spectrum from its surrounding nebula. Some of the new TeV sources are also expected to originate from old supernova remnants (SNR). In young SNRs, X-ray imaging above 10 keV is expected to disentangle the leptonic from the hadronic emission component in the TeV shells, through distinct spectral properties of the secondary electrons produced in hadronic collisions. As SNRs get older, the high energy electron component is expected to fade away. This should allow to verify the picture though spectral evolution of the source population. Starting from the lessons we have learned so far from X-ray follow-up observations of unidentified TeV sources, prospects for Simbol–X to resolve open questions in this field will be discussed.

90. Latest X-ray observations of the gamma-ray loud binaries

Maria Chernyakova (DIAS, Dublin)

Oral

Authors: M.Chernyakova, A. Neronov

gamma-ray loud binary systems are a newly identified class of X-ray binaries in which either accretion onto the compact object (a neutron star, or a black hole), or interaction of an outflow from the compact object with the wind and radiation emitted by the massive companion star leads to the production of very-high energy gamma-ray emission. Three such systems PSR B1259-63, LSI +61 303 and LS 5039, have been firmly detected as persistent or regularly variable TeV gamma-ray emitters. In my talk I will review the multi wavelength properties of these systems, including the latest X-ray observations by RXTE, XMM, Chandra, Swift and Suzaku satellites, and try to explain the observed spectral variability.

91. Studying rotation-powered pulsars with Simbol–X

Werner Becker (MPE Garching)

Oral

Authors: Werner Becker (MPE), Giancarlo Cosumano (INAF-IASF), Enrico Massaro (Universita' La Sapienza, Roma), Teresa Mineo (INAF-IASF), Luciano Nicastro (INAF-IASF)

As a result of observations with the satellite observatories Einstein, ROSAT, ASCA, BeppoSAX, Chandra and XMM-Newton, 89 rotation-powered pulsars were detected at X-ray energies by mid 2008. Thus, in nearly ten years of operation XMM-Newton and Chandra have almost tripled the number of detected X-ray pulsars compared to what was known at the end of the ROSAT mission in February 1999. This progress clearly goes along the increase of sensitivity and angular resolution of the available X-ray telescopes. While XMM-Newton with its super collecting power allows to obtain timing and spectral information even from faint and million years old pulsars, Chandra stands for sub-arcsecond angular resolution which made it possible to detect and study neutron stars located in source confused regions such as globular clusters and supernova remnants. However, many questions related to the pulsar emission mechanisms and to the neutron star equation of state are still poorly known and require an even more sensitive instrument to be addressed adequately. In my talk I will summarize the recent results on the X-ray emission properties from rotation powered pulsars with the prospects for studying these sources with Simbol–X.

Clusters of Galaxies

92. Non-thermal emission in clusters of galaxies: the importance of a joint LOFAR/Simbol–X view

Chiara Ferrari (Observatoire de la Côte d'Azur)

Invited Talk

Authors: Chiara Ferrari

Deep radio observations of galaxy clusters have revealed the existence of diffuse radio sources ("halos" and "relics") related to the presence of relativistic electrons and weak magnetic fields in the intracluster volume. In this talk, I will firstly outline our current knowledge about the presence and properties of this non-thermal cluster component. Secondly, I will show the importance of combining galaxy cluster observations by new-generation instruments such as LOFAR and Simbol–X: despite the recent progress made in observational and theoretical studies of the non-thermal emission in galaxy clusters, a number of open questions about its origin and its effects

on the thermo-dynamical evolution of galaxy clusters need to be answered. A deeper knowledge of the non-thermal cluster component, together with statistical studies of radio halos and relics, will allow to test the current cluster formation scenario and to better constrain the physics of large scale structure evolution.

93. Future prospects for the detection and characterization of non-thermal emission in galaxy clusters

Silvano Molendi (IASF-Milano/INAF, Italy)

Oral

Authors: S.Molendi

Starting form a critical assessment of the observational evidence gathered over the last decade I review future prospects for the detection and characterization of non-thermal emission in galaxy clusters. I first explain why amongst missions currently under development Simbol–X provides one of the most adequate set of instrumental properties to investigate non-thermal emission in clusters. I then provide estimates of the sensitivity that Simbol–X is expected to reach highlighting the often underrated role played by instrumental issues and data analysis procedures.

94. Hard X-ray tails in galaxy groups and poor clusters: prospects for Simbol–X

Gabriel Pratt (MPE Garching, Germany)

Oral

Authors: G.W. Pratt

During the assembly of a group or cluster of galaxies, shocks propagate through the ICM and heat the gas to the observed X-ray emitting temperatures. Particle acceleration is thought to occur as these shocks plough through the ICM, producing non-thermal electrons and ions, which in turn can lead to synchrotron radio, inverse Compton EUV and hard X-ray, and gamma ray emission. With current instrumentation, the detection of the non-thermal hard X-ray tails is complicated by poor sensitivity and limited bandpass, leading to confusion with the thermal emission from the ICM. This is especially true since many of the most spectacular mergers, hosting the most obvious radio haloes, are very hot systems with thermal emission which peaks at or beyond the bandpass of current X-ray satellites. Observations of galaxy groups can help in this respect since in principle their thermal and non-thermal emission peaks are well separated. In this context, I will discuss the possibility of using Simbol–X to constrain the contribution of non-thermal emission to the total energy budget in these systems, and the prospects for synergies with upcoming low frequency radio facilities such as LOFAR.

95. AstroParticle Physics in cosmic structures with Simbol–X: DM, CRs, BHs and B-fields

Sergio Colafrancesco (ASI-ASDC)

Oral

Authors: S. Colafrancesco

We discuss the relevance of Hard X-ray observations (with specific emphasis on those planned with SimbolX) of Large Scale Structures in the universe, and especially of galaxy clusters, to unveil several issues that are relevant for Cosmology and Astro-Particle Physics of cosmic structures: the nature of Dark Matter, the origin of cosmic rays, the role of magnetic fields and the impact of black holes.

96. Hard X-ray emission from galaxy clusters observed with INTEGRAL and prospects for Simbol–X

Dominique Eckert (ISDC, University of Geneva)

Poster

Authors: Dominique Eckert, Stéphane Paltani, Thierry Courvoisier

Some galaxy clusters are known to contain a large population of relativistic electrons, which produce radio emission through synchrotron radiation. Therefore, it is expected that inverse-Compton scattering of the relativistic electrons with the CMB produce non-thermal emission which should be observable in the hard X-ray domain. To the present day, several claims of such detection have been made, in particular from the Coma and A2256 clusters (BeppoSAX), and recently from the Ophiuchus cluster (INTEGRAL). In this presentation, we will focus on the recent results by INTEGRAL, which shed a new light on the non-thermal emission thanks to its angular resolution and sensitivity in the hard X-ray range. We will also present the exciting prospects in this field for Simbol–X, which will allow us to detect the non-thermal emission in a number of clusters and map the magnetic field throughout the intra-cluster medium.

97. AGN heating and ICM cooling in the HIFLUGCS sample of galaxy clusters

Rupal Mittal (Argelander-Institut für Astronomie)

Poster

Authors: Rupal Mittal, Thomas Reiprich

We have carried out an intensive study of the AGN heating-ICM cooling network by comparing various cluster parameters of the HIFLUGCS sample to the integrated radio luminosity of the central AGN, L_R, defined as the total synchrotron power between 10 MHz and 15 GHz. We adopt the central cooling time, t_cool, as the diagnostic to ascertain cooling properties of the clusters and classify clusters with t_cool < 1 Gyr as strong cooling core (SCC) clusters, with 1 Gyr < t_cool <7.7 Gyr as weak cooling core (WCC) clusters and with t_cool > 7.7 Gyr as non-cooling core (NCC) clusters. We find 48 out of 64 clusters (75%) contain cluster center radio sources (CCRS) cospatial with or within 50 h^{-1}_{71} kpc of the X-ray peak emission. Further, we find that the probability of finding a CCRS increases from 45% to 67% to 100% for NCC, WCC and SCC clusters, respectively, suggesting an AGN-feedback machinery in SCC clusters which regulates the cooling in the central regions.

We find L_R in SCC clusters depends strongly on the cluster scale such that more massive clusters harbor more powerful radio AGN. The same trend is observed between L_R and the classical mass deposition rate, MDR, albeit much stronger, in SCC and partly also in WCC clusters. We also perform correlations of the 2MASS K-band luminosity of the brightest cluster galaxy, L_BCG, with L_R and cluster parameters. We invoke the relation between L_BCG and black hole mass, M_BH, and find a surprisingly tight correlation between M_BH and L_R for SCC clusters. We find also an excellent correlation of L_BCG with M500 and L_X for the entire sample; however, SCC clusters show a tighter trend in both the cases. We discuss the plausible reasons behind these scaling relations in the context of cooling flows and AGN feedback.

98. Metallicity maps - X-ray observations versus simulations

Lorenzo Lovisari (Institut für Astro- und Teilchenphysik, University of Innsbruck)

Poster

Authors: Lovisari Lorenzo, Kapferer Wolfgang, Schindler Sabine

We are performing a statistical investigation on the metal distribution in galaxy clusters analysing 2D metal maps obtained both from observations and hydro-dynamic simulations. We test the morphology and the variations in the abundance map and test whether there are correlations with other X-ray properties. We also investigate how uncertainties in the temperature affect the metallicity determination. In addition we study the efficiency and spatial distribution of the various enrichment processes like galactic winds or ram-pressure stripping by a quantitative comparison of metal maps obtained from simulations and observations.

Neutron stars and accreting pulsars

99. Cyclotron Lines in Accreting Neutron Star Spectra

Joern Wilms (Remeis-Observatory / ECAP)

Invited Talk

Authors: J. Wilms (for the MAGNET collaboration)

Cyclotron lines are caused by transitions of electrons between Landau levels in the strong magnetic fields of the accretion columns of accreting neutron stars. They provide the most direct way to measure the magnetic fields of neutron stars. In this review the results of observations of cyclotron line sources with currently flying satellite missions are summarized and discussed in the context of new models for the formation and shape of the lines. Finally the talk will also discuss the prospects for the observation of cyclotron lines with Simbol–X.

100. Simbol–X view of accreting pulsars

Dmitry Klochkov (Institut fuer Astronomie und Astrophysik Tuebingen, Uni. Tuebingen)

Oral

Authors: D. Klochkov, A. Santangelo, E. Kendziorra, C. Tenzer, G. Puehlhofer

We discuss the main perspectives of Simbol–X in studies of accreting X-ray pulsars. Currently, only non-focusing instruments, with limited sensitivity, are operated above 10 keV. As a result, the broad band X-ray continuum can be studied in details only in the few cases of bright persistent accreting pulsars and during bright outbursts of transient sources. In order to understand the physics of the emission processes in accreting pulsars, however, one needs systematic studies of the broad-band X-ray spectra of many sources as a function of luminosity and rotational phase of the neutron star. At hard energies, especially interesting are narrow spectral features such as Cyclotron Resonant Scattering Features (CRSF) whose shape and behavior may shed light on the geometry and physical conditions at the site of X-ray emission. We show that Simbol–X will be able to perform such systematic study and help us to discern between different theoretical models of X-ray emission.

101. The accretion powered spin-up of GRO J1750-27

Peter Kretschmar (ESA-ESAC)

Oral

Authors: P. Kretschmar, S.E. Shaw, A.B. Hill, S. Brandt, J. Chenevez, E. Kuulkers

The transient Be X-ray pulsar GRO J1750-27 was originally detected in 1995 by CGRO/BATSE during a giant outburst. After a long period of quiescence the source was detected in another outburst early 2008. Following this outburst with hard X-ray data from INTEGRAL and Swift, the orbital parameters have been confirmed and improved and a clear spin-up measured.
For the first time the broad-band spectrum and pulse profile has been obtained, allowing an estimation of source distance and magnetic field strength. We discuss the evolution of the spectrum and pulse profiles over the outburst.

102. The Simbol–X view of LMXRB with Neutron Stars

Andrea Santangelo (IAAT-Kepler Center Tuebingen)

Oral

Authors: A. Santangelo, B. Mueck, D. Klochkov, S. Piraino, E. Kendziorra, T. Schanz

Spectra of LMXRBs often exhibit broad emission lines (FWHM up to 1 keV) E~6.4-6.9 keV. These are usually identified with Kalpha radiative transitions of iron at different ionization states. As in Black Hole systems, they could originate from emission reprocessed by the accretion disc surface illuminated by the primary

comptonized spectrum. In this case Dopplerand relativistic effects due to the strong field in the vicinity of the NS, would smear and shift the reflected feature. The predicted broad profile depends on the geometry - inclination and inner radius- of the system. A relativistic origin of the broad Fe 4U 1728-34 was already suggested by Piraino et al. (2000). Recently, relativistic line profiles have been observed with XMM in the and Suzaku in several LMXBs Ser X-1 (Cackett et al., 2008). Of course, other explanations, which invoke thermal and/or bulk comptonization, have been suggested and are worth to be explored. LMXRBs exhibit, also, temporal variability phenomena up to kHz frequencies. Usually two simultaneous kHz QPOs are present in the power spectrum, with frequencies ranging from 400 to 1300 Hz with one usually identified with the Keplerian orbital frequency at the inner edge of an accretion disk. A key test of this interpretation would be to find evidence for changes in the disk properties measured via spectral changes (e.g. line variations) correlated with QPOs variation. Detection of such a correlation would be a striking confirmation of the interpretation of the kHz QPOs frequency as a Keplerian orbital frequency. Furthermore, if this interpretation is correct, simultaneous knowledge of the radius and associated orbital frequency would lead to an estimate of the compact object mass in accreting neutron stars, i. e. in systems which have undergone significant accretion. In this paper we show how the broadband capability of Simbol–X and its sensitivity can provide relevant results in this exciting field of studies.

103. Prospects for Simbol–X observations of bursts from Soft-Gamma-ray Repeaters

Sandro Mereghetti (INAF-IASF Milano)

Oral

Authors: S. Mereghetti, A. Tiengo, P.Esposito, et al.

Soft Gamma-ray Repeaters are isolated neutron stars with extremely strong magnetic fields (B~10^15 G) powering both their persistent X-ray emission and their characteristic short (<1 s) and hard bursts.
Recent results have shown that these bursts are not only emitted by the handful of known SGRs, but also by other magnetar candidates, such as the Anomalous X-ray Pulsars and possibly other peculiar galactic sources.

I will review the recent observations and theoretical developments in this field and discuss the contribution that Simbol–X can give thanks to its broad band spectroscopic observations of bursts from SGRs and AXPs.

104. How Simbol–X will reveal the supergiant HMXBs

Sylvain Chaty (Université Paris Diderot/CEA Saclay)

Poster

Authors: S. Chaty

The INTEGRAL satellite has revealed a major population of supergiant High Mass X-ray Binaries in our Galaxy, revolutionizing our understanding of binary systems and their evolution. This population, constituted of a compact object orbiting around a supergiant star, have unusual properties, either being extremely absorbed, or exhibiting very short flares.
I will first describe the characteristics of these sources, that only intensive multi-wavelength observations have led us to disentangle, before showing that Simbol–X, thanks to its energy range and sensitivity, will allow us to go further in the understanding of these supergiant HMXBs.

105. Spectral variability in the obscured HMXB IGR J16320-4751

Juan Antonio Zurita Heras (AIM/CEA-Saclay)

Poster

Authors: J.A. Zurita Heras, S. Chaty, J. Rodriguez

We monitored the obscured HMXB IGR J16320-4751 with the X-ray mission XMM-Newton. Because of the strong interaction between the supergiant wind and the X-ray radiation of the accreted material, these sources are ideal laboratories to study the relation between the column density and the orbital period and derive the properties of the stellar wind. We will also show how the soft X-ray excess can bring important results in this field. Indeed, due to the limited range of XMM-Newton and the current soft X-ray observatories, a strong

degeneracy between the parameters of the continuum and the measure of the column density may exist. By extending the hard X-ray range, one may expect the parameters of the continuum to be better constraints, and in turn obtain more reliable measurements of the column density.

106. A new Comptonization model and its application to LMXBs

Adamantia Paizis (INAF-IASF)

Poster

Authors: A. Paizis, R. Farinelli, L. Titarchuk, F. Frontera on behalf of a larger collaboration

We have developed a new Comptonization model whose aim is to propose, for the first time, a self consistent physical interpretation of he complex spectral evolution seen in LMXBs. Particular attention is given to the transient powerlaw-like hard X-ray (>30 keV) tails observed in LMXBs hosting a neutron star, that we interpret in the framework of the bulk motion Comptonization process. We note that our model is not specific to dynamical (i.e. bulk) Comptonization but it includes in a coherent way different spectral shapes such as simple blackbody (neither thermal nor dynamical Comptonization), thermal Comptonization (similarly to CompTT) as well as a combination of thermal and dynamical Comptonization.

The model and its application to a sample of LMXBs using different high energy emission spectra will be presented and compared to the Simbol–X expected capabilities.

107. Explaining the broadband X-ray emission of magnetars candidates: a Resonant Cyclotron Scattering Model

Silvia Zane (University College London, Mullard Space Science Laboratory, UK)

Poster

Authors: S Zane (on behalf of a large team)

Soft gamma-ray repeaters (SGRs) and anomalous X-ray pulsars (AXPs) are peculiar X-ray sources which are believed to be magnetars: ultra-magnetized neutron stars with surface field in excess of 1E14 G, i.e. well above the QED threshold. Spectral analysis is an important tool in magnetar astrophysics since it can provide key information on the emission mechanisms. The fit of the soft X-ray (<10 keV) spectra of AXPs and SGRs proved that a model consisting of a blackbody (kT ~ 0.3-0.6 keV) plus a power-law (photon index ~ 2-4) could successfully reproduce the observed emission. Moreover, recent INTEGRAL observations have shown that magnetars emit substantial radiation at higher energies, up to a few hundreds of keV; their high energy spectra are tipically modelled by a further power law which in some cases has been proved to exhibit a strong dependence on the spin phase.

However, a convincing physical interpretation of the various spectral components is still missing and our knowledge of the broadband emission is severely hampered by the impossibility, so far, to carry out simultaneous observations in the whole energy range.

In this talk, I will summarise the present status of the art and our first attempts to model the broadband spectra of magnetars within a self consistent, physical scenario. I will then present the predictions of a synthetic model that we calculated with a new magnetic montecarlo 3D radiative code. Our code accounts for resonant cyclotron upscattering of soft thermal photons (emitted by the star surface), by a population of relativistic electrons which thread the magnetosphere. Polarization and QED effects are consistently accounted for, as well different configurations for the magnetosphere. I will discuss the predicted spectral properties in the 0.1-100 keV range, the application to existing magnetar data and the role of future Simbol X observations.

108. Taking the pulse of magnetar flares

GianLuca Israel (INAF - OA Roma)

Poster

Authors: Israel et al.

In the latest years a number of important results have opened new horizons in the study and understanding of a class of high energy emitting isolated neutron stars: the "magnetars". These are thought to shine in the X-rays due to the decay of the strongest magnetic fields present in the Universe (up to 10^15 Gauss).

In this talk the results obtained through the monitoring of their variability on timescales of years and encompassing flux variations larger than 100, will be outlined. In particular, the study of the spectral/timing properties of the initial phases of large flares (duration > 1yr) displayed by an increasing number of magnetars has allowed us to infer several new important information. These results will be also considered in the context of the forthcoming mission Simbol–X and its expected contribution in the development of the field.

109. IGRJ16479-4514: the first eclipsing Supergiant Fast X-ray Transient?

Enrico Bozzo (INAF-OA Roma)

Poster

Authors: E. Bozzo, L. Stella, G. Israel, M. Falanga, S. Campana

Supergiant fast X-ray transients are a new class of high mass X-ray binaries recently discovered with INTEGRAL. Hours long outbursts from these sources have been observed on numerous occasions at luminosities of ~10^36-10^37 erg/s, whereas their low level activity at ~10^32-10^34 erg/s has not been deeply investigated yet due to the paucity of long pointed observations with high sensitivity X-ray telescopes. Here we report on the first long (~32 ks) pointed XMM-Newton observation of IGR J16479-4514, a member of this new class. This observation was carried out in March 2008, shortly after an outburst from this source, with the main goal of investigating its low level emission and physical mechanisms that drive the source activity. Results from the timing, spectral and spatial analysis of the EPIC-PN XMM-Newton observation show that the X-ray source IGRJ16479-4514 underwent an episode of sudden obscuration, possibly an X-ray eclipse by the supergiant companion. We also found evidence for a soft X-ray extended halo around the source that is most readily interpreted as due to scattering by dust along the line of sight to IGRJ16479-4514. We discuss this result in the context of the gated accretion scenarios that have been proposed to interpret the behaviour of supergiant fast X-ray transient.

110. Identifying a new intermediate SFXT: the 30 day period of SAX J1818.6-1703

Adam Hill (Laboratoire d'Astrophysique Observatoire de Grenoble)

Poster

Authors: A. B. Hill, A. J. Bird, A. Bazzano, V. A. McBride, V. Sguera, S. E. Shaw & H. J. Watkins

Supergiant fast X-ray transients (SFXTs) are recently discovered members of the expanding family of high mass X-ray binaries. They represent a population of sources which show transient activity and are associated with blue supergiant optical counterparts. To date INTEGRAL has observed 9 SFXTs; two of which have been confirmed to be X-ray pulsars. The fast, transient nature of these sources makes them a challenge to study and understand. Recently, periodic behaviour has been discovered in 4 such systems and has been attributed to orbital motion.

We present here the discovery of a 30 day period in SAX J1818.6-1703 and the implication it and similar systems have on the interpretation and understanding of the proposed models explaining SFXT behaviour.

111. Pulsed thermal emission from XMMU J054134.7-682550

Antonios Manousakis (ISDC Data Center for Astrophysics)

Poster

Authors: A.Manousakis, R. Walter, M. Audard, T. Lanz

XMMU J054134.7-682550, located in LMC, featured a type II outburst in August 2007. Soft X-rays has been detected, so far observed in several X-ray binaries, and interpreted as a signature of hard X-ray reprocessing on the inner edge of the accretion disk. We analyzed XMM-Newton (EPIC-MOS) and RXTE (PCA) data in order to derive spectral and temporal characteristic of the system throughout the outburst. Spectral variability, spin period evolution, energy dependent pulse shape are discussed. The outburst spectrum (L_{X}~3 * 10^{38} erg/s~L_{EDD}) can be modeled using, cutoff powerlaw, blackbody, disk emission, and cyclotron absorption line. The magnetosphere (~750 km) and the thickness of the inner accretion disk (width of ~100 km) can be

constrained. The blackbody component shows a sinusoidal behavior. The spin-up of the pulsar was significant during the outburst, signature of a huge accretion rate and/or a rather small pulsar. The future focusing mission Simbol–X will provide similar capabilities to the ongoing missions XMM-Newton and RXTE simultaneously.

112. Focused study of thermonuclear bursts on neutron stars

Jerome Chenevez (DTU National Space Institute, Denmark)

Poster

Authors: Jérôme Chenevez

X-ray bursters are a class of Low Mass X-Ray Binaries where accreted material from a donor star undergoes rapid thermonuclear burning in the surface layers of a neutron star. The flux released can temporarily exceed the Eddington limit and drive the photosphere to large radii. Such photospheric radius expansion bursts likely eject nuclear burning ashes into the interstellar medium, and may make possible the detection of photoionization edges. Indeed, Theoretical models predict that absorption edges from 58Fe at 9.2 keV, 60Zn and 62Zn at 12.2 keV should be detectable by Simbol X. A positive detection would thus probe the nuclear burning as well as the gravitational redshift from the neutron star. Moreover, likely observations of atomic X-ray spectral components reflected from the inner accretion disk have been reported. The high spectral resolution capabilities of Simbol X may therefore make possible to differentiate between the potential interpretations of the X-ray bursts spectral features.

113. A physical model for the spectral energy distribution of 4U 0115+634 in outburst

Carlo Ferrigno (ISDC/IAATübingen, Germany)

Poster

Authors: C. Ferrigno P.A. Becker A. Santangelo A. Segreto T. Mineo

We study the spectral emission of the high mass X-ray binary pulsar 4U 0115+634 using a thermal and bulk Comptonization model based on the physical properties of the object. We analyze the Beppo-SAX data of the 1999 giant outburst taken 12 days after the maximum in the energy range 2-100 keV focusing first on the average emission and then on the phase resolved spectra.
The emission can be ascribed to thermal and bulk Comptonization of the seed photons produced by cyclotron cooling in the accretion column and by an halo at lower temperature. We are then able to explain the energy dependency of the pulse profile shape.
The fitted parameters change smoothly as function of the phase on the main and secondary peaks, showing that we are already able to approximately investigate the physical properties of the system, but that the angular dependency of the emission will be an essential ingredient of any future modelling. As a further result, we demonstrate the presence of a sixth cyclotron harmonic at ~70 keV in the descending edge of the main pulse.

114. The Simbol–X view of Z-sources

Antonino D'Aì (Univ. Of Palermo, DSFA)

Poster

Authors: Antonino D'Aì, Rosario Iaria, Tiziana Di Salvo, Natale Robba

We present recent results on the spectroscopic study of bright accreting NS systems and compare them with future developments made achievable with the Simbol–X satellite.

115. X-ray pulsars in hard X-rays: spectral and timing properties

Alexander Lutovinov (SRI, Moscow)

Poster

Authors: A.Lutovinov, S.Tsygankov

n.a.

Observatory science

116. Young Stellar Objects From Soft to Hard X-Rays

Manuel Guedel (ETH Zuerich)

Invited Talk

Authors: Manuel Guedel

Magnetically active stars are the sites of efficient particle acceleration and plasma heating, processes that have been studied in detail in the solar corona. Investigation of such processes in young stellar objects in star-forming regions is much more challenging as most of the soft X-ray spectrum may be absorbed by dense gas envelopes, and radio studies of magnetic activity are often prevented by free-free absorption in winds and outflows. On the other hand, there is evidence for violent magnetic energy release in very young stellar objects.
Some of the phenomenology may be due to the particular environment common to these objects: the presence of disks, accretion streams, and outflows and jets. The high-energy output of young stars, both in photons and particles, is of great importance for the ionization, heating, and chemical processing of disks and envelopes, disk evaporation, and finally the formation and evolution of young planetary atmospheres.
Simbol–X's hard X-ray range (10-100 keV) will offer unique access to violent phenomena around young stars as it penetrates typical gas columns even toward protostars. The full range of energies accessible by Simbol–X will characterize both thermal and non-thermal processes in magnetically controlled regions simultaneously and thus uncover crucial connections between particle acceleration, magnetic fields, and plasma heating in these environments. I will summarize the current view of these processes in young stars and discuss what we can expect Simbol–X to contribute to the field of young stellar and planetary research.

117. Non-thermal processes in colliding-wind massive binaries: the contribution of Simbol–X to a multiwavelength investigation

Michaël De Becker (University of Liège)

Oral

Authors: De Becker M., Blomme R., Micela G., Pittard J.M., Rauw G., Romero G.E., Sana H., Stevens I.R.

Several colliding-wind massive binaries are known to be non-thermal emitters in the radio domain. This constitutes a strong evidence for the fact that an efficient particle acceleration process is at work in these objects. The acceleration mechanism is most probably the Diffusive Shock Acceleration (DSA) process in the presence of strong hydrodynamic shocks due to the colliding-winds. In order to investigate the physics of this particle acceleration, we initiated a multiwavelength campaign covering a large part of the electromagnetic spectrum. In this context, the detailed study of the hard X-ray emission from these sources in the Simbol–X bandpass constitutes a crucial element in order to probe this still poorly known topic of astrophysics. It should be noted that colliding-wind massive binaries should be considered as very valuable targets for the investigation of particle acceleration in a similar way than supernova remnants, but in a different part of the parameter space.

118. Hard X-ray Flux from Low-Mass Stars in the Cygnus OB2 Association

Marilena Caramazza (Universita' degli studi di Palermo, INAF-OAPA)

Oral

Authors: M. Caramazza, J.J. Drake, G. Micela, E. Flaccomio

The Cygnus OB2 association, the central engine of the Cygnus X star-forming region, is the subject of an extensive INTEGRAL Key Project that will accumulate 6Ms of observations. Analysis of 2Ms of observations

by De Becker and co-workers provides the most sensitive limit yet obtained on hard X-ray emission from the cluster.
We investigate the X-ray emission in the 20-40 keV band expected from the flaring low-mass stellar population in Cygnus OB2. We discuss whether such emission needs to be considered in the interpretation of existing and future X-ray observations of the region, and whether such observations might provide insights into high energy processes on low-mass pre-main sequence stars.
The total hard X-ray flux from low-mass stars is estimated by assuming the observed soft X-ray emission is due to a superposition of flares. We further assume the ratio of hard X-ray to soft X-ray emission is described by a scaling found for solar flares by Isola and co-workers.
We estimate a low-mass stellar hard X-ray flux in the 20-40 keV band in the range ~2x10^31 - 5x10^33 erg/s and speculate the limit of this values.
Hard X-ray emission could lie at a level not much below the current observed flux upper limits for Cygnus OB2. If this emission can be detected, it would provide insights into the hard X-ray production of large flares on pre-main sequence stars. We highlight the penetrating power of hard X-rays from low-mass stellar populations as a possible pointer to our Galaxy's hidden star forming clusters and super-clusters using more sensitive observations from future missions.

119. Five years of hard X-ray monitoring of the Sgr B2 molecular cloud

Regis Terrier (APC CNRS/Universite Paris 7)
Oral

Authors: R. Terrier, G. Bélanger, A. Goldwurm, G. Ponti, G. Trap

A number of molecular clouds around the Galactic Centre (GC) emit strong neutral iron fluorescence line at 6.4 keV, as well as hard X-ray emission up to 100 keV. The origin of this emission has long been a matter of controversy: irradiation by low energy cosmic ray electrons or X-rays emitted by a nearby flaring source in the central region. In the latter case, an interesting candidate is a flare from Sgr A* with a peak luminosity 6 order of magnitude above its current quiescent level that would have occured about 300 year ago. A recent evidence for time variability in the iron line intensity that has been detected in the Sgr B2 clearly favours the reflexion scenario. We present here an overview of the Central Molecular Zone obteined after 5 years of Integral monitoring of the GC. In particular, we show a lightcurve of Sgr B2 that reveals an important decrease in the hard X-ray flux over the last years and discuss its implications. We finally discuss perspectives with Simbol–X.

120. ^{44}Ti nucleosynthesis lines & hard X-ray continuum in young Galactic SNRs: From INTEGRAL/IBIS to Simbol–X

Matthieu Renaud (APC, Paris)
Oral

Authors: M. Renaud, R. Terrier, F. Lebrun, J. Vink, A. Decourchelle, J. Ballet

SNRs are the privileged sites of cosmic nucleosynthesis and efficient particle accelerators in the Galaxy. Observations in the hard X-ray / soft gamma-ray domain of these sources are invaluable to study these two major topics in high-energy astrophysics, through the two low-energy gamma-ray lines originated from the radioactive decay of 44Ti and the hard X-ray nonthermal continuum emission. In this contribution, we will present the latest INTEGRAL/IBIS results on young SNRs with a particular attention to G1.9+0.3, recently revealed as the youngest known Galactic SNR, and Cas A and Tycho, two well-known historical SNRs. Exciting perspectives with Simbol–X will also be adressed.

121. Electromagnetic signals from collapsing magnetized stars

Volodymyr Kryvdyk (University of Kyiv)
Poster

Authors: Volodymyr Kryvdyk

The generations of the electromagnetic signals in the magnetospheres of collapsing stars are considered. The charged particles will accelerate by the gravitational collapse in stellar magnetosphere. These particles will

generate the non-thermal radiation. As follow from analysis, the collapsing stars can by powerful sources of the charged particles and the non-thermal radiation in a wide bandwidth, from gamma to radio waves. The radiation flux can be observed in the form of radiation bursts with duration equal to the stellar collapse time. The radiation flux depends on the distance to the star, its magnetic field, and the particles spectrum in the magnetosphere. The radiation flux is calculated for various collapsing stars with initial dipole magnetic fields and an initial power-series, relativistic Maxwell, and Boltzmann particles energy distribution in the magnetosphere. This radiation bursts can be observed by means of modern astronomical instruments.

122. Particle acceleration in stellar wind collisions

Roland Walter (Geneva Observatory)

Poster

Authors: R. Walter, J.-C. Leyder

Relativistic particle acceleration takes place in colliding-wind binaries (CWB), leading to the emission of hard X-rays and gamma-rays through inverse Compton scattering. Such non-thermal emission has been detected in eta Carinae by INTEGRAL. Sufficient spatial resolution and sensitivity is essential to separate the emission from CWB in the very crowded galactic plane. The TeV emission detected by H.E.S.S. in the stellar cluster Westerlund 2 may also be the signature of stellar wind collisions. The averaged emission from eta Carinae in the 22–100 keV energy range is very hard and its luminosity of 7E33 erg/s is in agreement with the predictions of inverse Compton models, and corresponds to about 0.1% of the energy available in the wind collision. The X-ray emission of eta Carinae is changing along its orbital period of 5.53 yr, and there are hints that the same might apply to its hard X-ray emission. The other CWB systems are not detected and their average emission is lower than expected at least for some well known systems featuring non thermal radio emission. With its improved resolution and sensitivity at hard X-rays, Simbol–X will perform a breakthrough in the understanding of particle acceleration in stellar wind collisions.

123. Iron Line complex from illuminated accretion disk atmospheres.

A. Rozanska (Copernicus Astronomical Center, Warsaw)

Poster

Authors: A. Rozanska, J. Madej

We present full set of model atmosphere equations corresponding to an accretion disk around a supermassive black hole illuminated by hard X-ray power-law. Model equations allow for multiple Compton scattering of radiation on free electrons, and for large relative photon-electron energy exchange. We present spectra in specific intensities integrated over disk surface. Outgoing intensity spectra show soft X-ray excess below 1 keV, and distinct K_{α} and K_{β} fluorescent lines of iron. We demonstrate the existence of the Compton Shoulder and clime that it can contribute to the asymmetry and equivalent widths of some observed lines in AGN.

124. Tidal disruption of small orbiting satellites around black holes

Claudio Germanà (INAF-Astronomical Observatory of Padova)

Poster

Authors: C. Germanà, U. Kostić

X-ray binaries with either a black hole or a neutron star show power spectra characterized by several enhanced fractions of power at given frequencies, such as Quasi Periodic Oscillations (QPOs). High frequency QPOs are typical of oscillation modes for matter orbiting in a strongly curved space-time.
Ray tracing in both Schwarzschild and Kerr metric of orbiting rigid bodies have been performed by several authors. We give preliminary results about light curves produced by clumps of free particles orbiting around a Schwarzschild black hole, therefore tracing deformations due to tidal interaction and differential rotation. Ray tracing is performed in a highly dynamical context. The second-order image of a free-particle due to gravitational lensing is taken into account.

From preliminary simulations we conclude that blobs of matter orbiting a Schwarzschild black hole emit most of the power at the keplerian frequency. Some power is emitted at both the radial and perihelium precession frequency of the blob's orbit. This power decreases as the eccentricity of the orbit becomes smaller. A systematic comparison of the properties of computed and observed power spectra in X-ray binaries is under way. In this context, the energy input is provided by the work done by the strong tidal force.

125. Optical pulsations of the Crab Nebula pulsar with AquEYE

Claudio Germanà (INAF-Astronomical Observatory of Padova)

Poster

Authors: C. Germanà, L. Zampieri, I. Capraro, C.Facchinetti, G. Naletto, T. Occhipinti, E. Verroi, P. Zoccarato, and C. Barbieri

The detailed knowledge of temporal behavior is one of the main sources of information about physical processes occurring inside many classes of astrophysical objects. To analyze fast temporal variability below the millisecond limit, mathematical tools based on Fourier analysis are widely adopted, and have produced remarkable results. For instance, sub-millisecond X-ray variability in X-ray binaries could provide a way to investigate the motion of matter in a strongly curved space-time. Multi-wavelength analysis from the X-ray to the optical band has been used to derive information about emission mechanisms and their nature in these peculiar sources.
As is well known, the Crab pulsar displays a light curve with a characteristic double peak profile having a period of 33 milliseconds, almost aligned in phase over the whole electromagnetic spectrum. Since it is the brightest pulsar in the optical band (V~16), its pulse profile has been extensively monitored by several authors; it is also used as a standard candle to calibrate fluxes and for testing instruments with high time resolution.
We have studied the optical light curve of the Crab pulsar by means of a novel photon counting instrument (dubbed AquEYE, the Asiago Quantum EYE), that has the capability to provide data with exceptionally high temporal resolution and time tagging accuracy of each incoming photon.

126. ISOC Science Data Archive (ISDA)

Marion Cadolle Bel (ESAC, Spain)

Poster

Authors: M. Cadolle Bel, O. R. Williams, P. J. Baeck, C. Arviset, N. Cheek, I. Leon, E. Parrilla, I. Ortiz, P. Osuna, J. Salgado, A. Domingo, J. M. Hesse, R. Gutierrez, D. Risquez, E. Solano, G. Belanger, S. de Castro, P. Kretschmar, E. Kuulkers and C. Sanchez-Fernandez

The ISOC Science Data Archive (ISDA, Madrid) is one of the two complete INTEGRAL archives, the other being maintained by the ISDC (Geneva). The two archives contain nearly identical data, but they have very different interfaces. The ISDA has the now standard ESA look-and-feel, and so its usage will be very familiar to users of, e.g., ESA's XMM-Newton archive. Version 2.7 of the ISDA was released in June 2007. It contains a number of new features, of which the Virtual Observatory (VO) compliant interface is perhaps the most significant. This capability means that it is possible to include INTEGRAL observations into the newly announced Google Sky, the Google Earth module for the sky (see http://earth.google.com/sky/skyedu.html). In order to encourage access to INTEGRAL data for a wider community, we aimed to provide a familiar interface with specially developed visualization and manipulation tools: the INtegral VIsualisation Tool and Explorer (INVITE, part of the ISDA since December 2006). It provides an easy and convenient method of manipulating light-curves from INTEGRAL and many other instruments. This means it can be launched from the ISDA and run on the client machine as a Java applet. Subsequent operations on even relatively large data-sets are rather rapid, since it then runs entirely on the client side. INVITE can also be used in a stand-alone mode to manipulate data from one or more FITS light-curves. INVITE allows the user to simultaneously display a number of light-curves, combine light-curves from different energy bands, generate hardness ratios and to rebin the light-curves in time. If a number of light-curves covering adjacent bands are available, these can be used to generate a "broadband" spectrum which can be passed to XSPEC. INVITE now also supports access to OMC light curves (supplied to us by courtesy of the LAEFF OMC archive) and IBIS images, which can be passed to ds9 for further imaging and manipulation.