X-RAY ASTRONOMY 2019

Current Challenges and New Frontiers in the Next Decade

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MULTI-MESSENGER AND TRANSIENT ASTRONOMY

MULTI-MESSENGER AND TRANSIENT ASTRONOMY / 101

What makes clumpy obscuration and X-ray occultation events?

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Most active galactic nuclei are seen through thick circum-nuclear gas and dust. Also, these column densities vary on time scales of days to years, indicating that the obscurer is made from clumps. We present the first clumpy obscurer model that reproduces eclipse events and column density distributions. We developed a new, open-source Monte Carlo code, XARS, to X-ray illuminate arbitrary geometries, including warped disks, outflowing winds and clump arrangements, and produce high S/N X-ray spectra for XSPEC for these. Preliminary fits show good agreement with NuSTAR spectral observations of some nearby AGN. I will demonstrate how the eROSITA survey will be able to systematically monitor millions of AGN on year-time scales for occultation events, probing the granularity of the obscuring medium.

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The place of TDE within the demography of Black Hole accretion

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Accretion onto a Black Hole seems to be a universal phenomena: it occurs in Black Holes of all masses, from galactic X-ray Binaries with stellar mass Black Holes, to extragalactic Active Galactic Nuclei harboring Supermassive Black Holes. A question naturally arises in this context: is the nature of the accretion onto Black Holes also universal across the mass range? In this work, we extend this question to the Tidal Disruption Events (TDEs). TDE, or the burst of emission due to the tidal disruption of stars by Supermassive Black Holes, is a unique laboratory to probe various high energy astrophysical phenomena much like the X-ray binaries, although in higher black hole masses ($10^{5\text{-}8}$ Msun). As such they might be considered as short-lived Active Galactic Nuclei. We try to find the place of these TDEs in the unification scheme of accretion phenomena across the different black hole masses. For this purpose, we selected a sample of TDEs observed by Swift, having a sufficient number of simultaneous UV and X-ray observations, as well as considerable emission in both the energy bands. We compare the UV to X-ray emission from this sample of TDEs with a sample of AGN of different masses and accretion rates, and from galactic Black Holes in the different states. This not only gives us an idea about the place of TDE in the demographic of BH accretions but also provide us more clues about the UV and X-ray emissions of TDEs themselves.

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The Exceptional X-ray Evolution of SN 1996cr in High Resolution

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We present X-ray spectra spanning 18 years of evolution for SN1996cr, one of the five nearest (~4 Mpc) SNe detected in the modern era. Chandra-HETG exposures allow us to resolve spectrally the velocity profiles of Ne, Mg, Si, S, and Fe emission lines and monitor their evolution as tracers of the ejecta-circumstellar medium (CSM) interaction. To explain the diversity of X-ray line profiles, we explore several possible geometrical models. Based on the highest S/N 2009 epoch, we find that a polar geometry with two distinct opening angle configurations and internal obscuration can successfully reproduce all of the observed line profiles. Furthermore, We extend this model to seven further epochs with lower S/N ratio and/or lower spectral-resolution between 2000-2018, yielding several interesting trends.

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The SXPS catalogues: improved transient detection with Swift-XRT

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The study of transient phenomena has entered a new phase with the advent of multi-messenger astronomy, as we now routinely search large areas of sky for an electromagnetic counterpart to a neutrino or gravitational wave trigger. This presents various new challenges. We need to understand the probability of serendipitously observing an X-ray transient during such follow up. We also need fast, reliable techniques to search a large sky area for transients, with a low rate of spurious detections, and ideally with a high level of completeness. However, it is often not easy to distinguish a transient source from a persistent but uncatalogued object.
In this talk I will address these questions using the revised Swift-XRT Point Source catalogues. I will summarise new techniques developed for reducing spurious detections due to artifacts such as stray light – which is of particular importance for other missions, especially Athena. I will also introduce the forthcoming "Live" SXPS catalogue and transient detector. This system will offer near real-time analysis of XRT data, including a constantly-updated upper limit calculator, and a real-time transient search algorithm. I will briefly highlight the transferability of these algorithms to missions such as THESEUS and Athena.

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The BH XRB researches highlighted with Insight-HXMT

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Black hole X-ray binareis show variability in flux on timescales of milliseconds to hours. It can probes the inner region of the accretion disk around BH. Insight-HXMT, the first Chinese X-ray astronomical satellite, was successfully launched on 2017 June 15. Its broad energy band (1-250 keV), large area in the hard energy band (~5000 cm^2 for 20-250 keV), and good time resolution provides us an exciting opportunity to study the spectral-timing properties of the X-ray binary systems especially at a higher energy. Here We will present the timing properties of new transient such as MAXI J1535- 571, MAXI J1820+070, and MAXI J1348-630, and known transients like GRS 1915+105 observed with Insight-HXMT.

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Exponential Temporal Decay of Extended Emissions in Short Gamma-Ray Bursts with Possible Luminosity – E-folding Time Correlation

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The origin of extended emissions following prompt emissions of short gamma-ray bursts (SGRBs) is in mystery. The long-term activity of the extended emission is responsible for promising electromagnetic counterparts to gravitational waves and, so that it may be a key to uncovering the progenitor of SGRBs. We investigate the early X-ray light curves of 26 SGRBs with known redshifts observed with the X-Ray Telescope aboard the Neil Gehrels Swift Observatory (Swift). We find that the exponential temporal decay model is able to describe the extended emissions comprehensively with a rest-frame e-folding time of 20 – 200 seconds. We also estimate the isotropic equivalent energies of the extended emission with the exponential decay model and of the prompt emission, compared with those of the prompt emission. Then, it is revealed that the extended emission is 0 – 3 orders of magnitude less powerful than the prompt emission. Finally, we find a strong correlation between the expected maximum luminosity and e-folding time which can be described by a power-law with an index of -3.3 and whose chance probability of $8.2*10^{-6}$ if there is no observation bias of *Swift*. In this presentation, we discuss the detail of the analysis and the physical model of the exponentially decaying extended emission.

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Classification of X-ray activities of GRS 1915+105 based on 10-year monitoring with MAXI and Swift.

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GRS 1915+105 is a black hole X-ray binary known for its characteristic variabilities of X-ray fluxes on timescales of minutes to hours, sometimes showing limit-cycle behavior in its X-ray light curves. More than ten patters of light curves has been recognized and classified. However, its long-term behavior, in particular, transitions among these variability classes have been difficult to study, since their classification required dedicated pointed observations.
Here, we investigated the long-term behavior of GRS 1915+105 using the data obtained over 10 years (2009-2019) with the Gas Slit Camera (GSC) of Monitor of All-sky X-ray Image (MAXI) on the ISS and the Burst Alert Telescope (BAT) of the Neil Gehrels Swift Observatory. MAXI scans the source for about 60 seconds every 92 minutes (ISS orbit). While it is difficult to recognize the variability class by the light curves within such short transits, we find it is possible to classify its activity state using the flux and the hardness ratio averaged over one day. With the appropriate choice of the energy bands for the flux and hardness ratio, the daily X-ray activities of GRS 1915+105 can be classified into four distinct branches in the hardness-intensity diagrams. We also find rules in transitions among the branches.
We attribute these state transitions in GRS 1915+105 to a "state machine" in the GRS 1815+105 system that can hold the memory of its state over several months. We suspect that the unique temporal behavior of this source among black hole X-ray binaries arises from its unusually large accretion disk.

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A tidal disruption event in an AGN

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We report the the discovery of a Tidal Disruption Event (TDE) occurred in the Active Galactic Nuclei. The X-ray spectral properties and the broad optical emission lines detected in the SDSS spectrum clearly revealed the AGN nature, with black hole mass of ~10^6 Msun and Eddington ratio of $\lambda_{Edd} = 0.6$. A sudden increase in flux during the second half of 2009 is shown in the long-term optical, UV and NIR light curves. After an initial decline, a plateau phase evidently emerged in the NUV and optical *u, g, r, i* light curves. The plateau phase in the NUV band is likely lagged behind the optical ones by approximately 70–80,days with also a much shorter duration, i.e. ~7– 15,days against ~40–50 days. The long-term light curves in the NUV and optical bands (after the plateau phase), as well as in the infrared band (VISTA NIR and WISE MIR), can be well fitted with a power-law with the form $f(t) = A*(t-t_0)^{-\beta}$. The value of β depends on the wavelength band, with β~ 0.7–1.0 in the NUV/optical bands, ~2.1–2.7 in the NIR *J, H, Ks*} bands, and ~ 1.2–1.4 in the MIR bands. The characteristics of the long-term multi-band light curves suggest that the observed increase in multi-band flux are caused by a TDE. The difference in the β value for different bands may indicate that the radiation in the optical/UV, MIR and NIR are from distinct regions which is in agreement with the scenario that the NIR and MIR flares are the echoes of the primary optical/UV emission. The lag between the NUV and optical plateau phase and the duration of the plateau phases, may imply that the optical/NUV flares are originated from the accretion disc. The plateau phase can be due to viscosity decay after the stellar debris interacting with the accretion disc of AGN, while the lag can be explained with the viscosity time-scale.

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Classifying eROSITA's Variable Source Population

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'eROSITA on-board the SRG satellite will perform the next large X-ray all-sky survey. With its 30-fold increased sensitivity relative to its predecessor ROSAT and its multi-visit, multi-cadence survey strategy, eROSITA will provide a new and deeper look into X-ray time domain astrophysics. To better handle the vast number of sources eROSITA is expected to detect, and assist with planning multi-wavelength follow-up, we are developing a pipeline for automated classification of the transient and variable source populations. We present an overview of this pipeline, and discuss the challenges of developing machine learning algorithms for classification of eROSITA's variable sources

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Investigating state transition luminosities of Galactic black hole transients in the outburst decay

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We have performed a comprehensive spectral and timing analyses of Galactic black hole transients (GBHTs) during outburst decay in order to obtain the distribution of state transition luminosities. Using the archival data of the Rossi X-ray Timing Explorer (RXTE), we have calculated the weighted mean for state transition luminosities of 11 BH sources in 19 different outbursts and for disk and power-law luminosities separately. We also produced histograms of these luminosities in terms of Eddington luminosity fraction (ELF) and fitted them with a Gaussian. Our results show the tightest clustering in bolometric power-law luminosity with a mean logarithmic ELF of -1.70 $\pm$ 0.21 during the index transition (as the photon index starts to decrease towards the hard state). We obtained mean logarithmic ELF of -1.80 $\pm$ 0.25 during the transition to the hard state (as the photon index reaches the lowest value) and -1.50 $\pm$ 0.32 for disk blackbody luminosity (DBB) during the transition to the hard-intermediate state (HIMS). We discussed the reasons for clustering and possible explanations for sources that show a transition luminosity significantly below or above the general trends.

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Detection of an IR burst in 4U 1728-34

Author(s): Federico Vincentelli[1] ; Yuri Cavecchi[1] ; Piergiorgio Casella[2] ; Simone Migliari [3] ; Maria Diaz-Trigo[4] ; Tomaso Belloni[5]

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We report for the first time the detection of X-ray burst in the IR K-band from the neutron star low mass X-ray binary 4U 1728-34. Using high time resolution IR observations we find a rapid increase of the IR emission 6 seconds after the appearance of an X-ray burst. We interpret such long delay as the light-travel time from the neutron star to the companion star surface, where the X-ray emission is reprocessed. From the value of the delay it was possible to infer a period between 3 and 8 hours, which is significantly higher from the one measured in past studies. Combining these new informations with the properties of the X ray bursts from the neutron star, I will discuss the physical implications regarding the nature of the companion star.

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Time Domain Studies of Neutron Star and Black Hole Populations: The Post Chandra and XMM-Newton Era

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We present prospects for studying stellar-origin black hole (BH) and neutron star (NS) populations in nearby galaxies, focusing on science topics that require next generation X-ray telescopes. Time domain measurements of BHs and NSs will revolutionize our understanding of their formation and evolution by linking source characteristics to accretion and galaxy parameters. The central themes include studying gravitational wave merger progenitor populations such as Wolf-Rayet X-ray binaries, elucidating the properties of ultraluminous X-ray pulsars that challenge accepted methods of accretion, and investigating various classes of unique transients (e.g., ultraluminous bursts) that remain unexplained. X-ray identification of compact object types also permits, for example, detailed studies of the role of supernova kicks in the dynamical evolution of X-ray binaries. We will present SIXTE simulations of Athena WFI observations of nearby galaxies and summarize the expected improvement in our understanding of these populations, in addition to other phenomena such as obscured HMXBs and Type I X-ray bursts.

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NICER+NuSTAR phase-resolved spectroscopy of quasi-periodic oscillations in the X-ray binary GRS 1915+105

Author(s): Edward Nathan[1] ; Adam Ingram[1]

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Low frequency quasi-periodic oscillations (QPO) with periods between ~10 s and ~0.05 s are often seen in the X-ray flux of accreting stellar-mass black holes. These are often attributed to the Lense-Thirring precession of the inner accretion flow, a General Relativistic effect caused by the spin of the black hole.
QPO phase-resolved spectroscopy, i.e. measuring how the X-ray spectrum changes with QPO phase, provides the best test of this model against alternative interpretations, since precession will lead to a rocking of the ~6.4 keV iron fluorescence line between Doppler red and blue shift over the course of each QPO cycle. We present a QPO phase-resolved spectral analysis of the bright black hole X-ray binary system GRS 1915+105 utilising simultaneous data from NICER and NuSTAR, using a novel method to track changes in the QPO centroid frequency during the course of the observation. The very high count rate and very broad band X-ray coverage (~0.3-79 keV) provided by the combination of NICER and NuSTAR makes this an ideal dataset for our analysis.

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X-ray/Optical Rapid Timing Correlations and the Resolving of Jet Base Activity in MAXI J1820+070

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Accreting LMXBs have long been known to emit relativistic jets from regions close to the compact object, but studying these regions is rendered difficult by the prohibitively short time scales associated with the inner jets, and the need to disentangle various compact emission components. In this talk, I will present some of the latest results in this field, where the new NICER instrument provides incredible coverage on last year's outburst of the BHB MAXI J1820+070, showing stunning sub-second variability. Combining with the optical instrument HiPERCAM/GTC, we have probed down to millisecond (optical) scales with unprecedented levels of clarity; a distinct lag in Optical/X-ray correlations of 170 milliseconds is seen in five different bands, with clear separation and differing levels of correlation dependant on wavelength, in accordance with expectations of MHD jet acceleration models. This work represents the highest quality data in the field to-date, greatly extending the work possible at the lower time resolutions of previous observations (such as GX 339-4 and V404 Cyg), and demonstrates the exciting potential of rapid coordinated multiwavelength timing.

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X-RAY TO RADIO STUDIES OF TRANSITIONAL BINARY SYSTEMS

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Transitional binaries are accreting pulsars observed in both Low Mass X-ray binary (LMXB) and Millisecond Radio Pulsar (MSP) phase.
They are considered the "smoking gun" of the so-called recycling scenario, first proposed in the 70s to describe the acceleration of radio pulsars to millisecond periods.
They alternatively emit their pulsation in radio or X-rays depending on the accretion phase they are in. Polarimetry measurements of the systems in both states will yield a better determination of the magnetic field at the disk edge in order to study the centrifugal inhibition of accretion of a peculiar propeller state for these systems.
We examine the case of the three known transitional systems for which the combination of radio observations with the Sardinia Radio Telescope (SRT) and the Imaging X-ray Polarimetry Explorer (IXPE) will address a number of unresolved questions on these intriguing objects and on neutron star evolution. We present the results of simulations which show the feasibility of the expected goals within IXPE observing cycles.

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RWI in disks around high spin black hole: how does it impact the observables

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The Rossby-Wave Instability (RWI) has been proposed as the origin of the fast quasi-periodic variability (HFQPOs) observed in black-hole binaries. Here we are using NOVAs, our Numerical Observatory of Violent Accreting systems, to follow the evolution of the RWI arising in the accretion disk of a black-hole for a large range of spin. The first aim is to prove the ability of the RWI to modulate the X-ray fluxes in a similar way as is observed.
But, thanks to NOVAs we can go further and explore possible imprint of the RWI in other observables.

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Search for multiwavelength emission from the binary millisecond pulsar J1836-2354A

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We present a multi-wavelength search for X-ray, optical and gamma-ray emission from the radio milli-second pulsar J1836-2354A (M22A, hereafter) hosted in the Galactic globular cluster M22 (NGC 6656), at 3.2 kpc far from Earth. In the last two decades, the cluster was observed with the X-ray satellites XMM-Newton, Chandra and Swift.
Thanks to the ~ 85 ks of exposure time, the 2014 Chandra observation allowed us to better constrain the position and the spectral parameters of the X-ray source. The radio and X-ray position are found being consistent within 1 sigma error box. The X-ray luminosity is $2\text{-}3{\cdot}10^{30}$ erg/s, in the 0.5-8 keV range, which makes M22A one of the faintest milli-second pulsar. The X-ray spectrum is consistent with a power-law of photon index ~1.5, which favour as possible origin of the X-ray emission an intrabinary shock between the pulsar wind and the matter ablated from the companion star.
We also searched for optical and gamma-ray counterparts, using data from the Hubble Space Telescope and Fermi-LAT catalogues, respectively. No optical counter part is found down to V=25.9 and I=24.7, which suggests a companion star not more massive than 0.1-0.2 M . The low X-ray luminosity and the upper limit on the mass of the companion allow us to speculate whether M22A is a black widow or rather a redback.
Finally, from the inspection of the latest 8-year Fermi-LAT catalogue, we found a gamma-ray source (4FGL J1836.8-2354), associated with the cluster. However, its 95% error ellipse does not encompass the radio/X-ray position of M22A, though it is very close.
Further deep studies on these type of sources will be possible thanks to the new generation of X-ray satellites, as for example ATHENA, which will be able to achieve highly significative detections of very faint X-ray milli-second pulsars, thanks to its high spectral capabilities and to the reduced instrumental background level. This will unable the scientific community to retrieve more information about the temporal and spectral features of these sources and eventually to discriminate between the different emission scenarios.

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Correlation between X-ray emission and stellar populations: the definitive study of nearby galaxies observed with XMM-Newton

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We present the analysis of all galaxies within a radius of 200 Mpc observed with XMM-Newton. These galaxies are the result of cross-correlation between the XMM-Newton archive and the HECATE catalogue, the most complete galaxy catalogue (~165,000 galaxies) of the local universe incorporating robust distances and stellar population parameters. In our analysis we will use data from all objects observed by XMM-Newton, including those with no formal detections (i.e. upper limits). The sample contains 2500 galaxies observed in more than 2100 observations. Using the full set of archival XMM-Newton data we measure their integrated X-ray luminosity and spectral parameters, in order to study the correlation between X-ray luminosity, star-formation rate, and stellar mass.

The long outburst of the black hole transient GRS 1716-249

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The spectral states of the Black Hole Binaries (BHBs) are characterised by different X/γ-ray luminosities, spectral shapes and timing properties over their outburst. The dominant hard X-ray component observed in the hard state spectrum is usually described by a cut-off power law and it is interpreted as thermal Comptonization.
We present the the spectral and timing analysis of X/γ-ray observations of the black hole transient GRS 1716-249 performed during the 2016-2017 outburst.
GRS 1716-249 increases the number of black hole transients showing outbursts with "failed" state transition. The XRT and BAT broad band spectra modeling with a thermal Comptonization plus a multi-color disk blackbody, showed spectral parameters characteristic of the HS-HIMS in agreement with the evolution of the root mean square amplitude of the flux variability. We find that, coherently with a scenario in which the disc moves closer to the compact object, the accretion disc could have reached the ISCO during the HIMS or the hot accretion flow might have re-condensated in an inner mini-disc.
The advent of γ-ray telescopes allowed to observe an additional high energy excess above 200 keV, during either hard (HS) or hard/intermediate states (HIMS). This component is usually explained as a Comptonization process due to a non-thermal electron populations in the corona, but there is not a unique theory to explain it, yet.
We observed that the X/γ-ray broad band spectrum of GRS 1716-249 showed a high energy excess in addition to the thermal Comptonization model adopted when using XRT and BAT data only.
The parameters obtained by the X/γ-ray broad band modeling, with the physical hybrid thermal/non-thermal model, are typical of hard state spectra. Moreover, we fitted our data with the magnetized hybrid Comptonization model BELM. This provided us with an upper limit on the magnetic field intensity of about 10^6 G.
Finally, we present our study with the aim to possibly explain the high energy excess observed during the hard state as due to jets. We computed a Spectral Energy Distribution with Swift, INTEGRAL, ATCA and REM observations during the hard spectral state of the source. We modeled the accretion flow with an irradiated disc plus Comptonization model and the jet emission with the compact jet internal shock emission model (ISHEM). This model assumes that the fluctuations of the jet velocity are driven by the X-ray timing proprieties of the source. Our results show that a jet with an electron distribution of p=2.1 can explain the high energy tail observed.

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New outburst with periodic modulation for a luminous supersoft source in NGC 300.

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Supersoft X-ray sources are characterized by black body temperatures below 100 eV and are found with luminosities that are explained by steady nuclear burning of hydrogen accreted onto white dwarf surfaces (in the range of 10^{36}-10^{38} erg/s) or are ultraluminous (>$2*10^{38}$ erg/s) requiring the presence of a neutron star or black hole. We report the discovery of a new outburst for the luminous supersoft source, SSS1, in NGC 300, thanks to a very long XMM-Newton observation performed on the 17-20 December 2016. A modulation with a period of 4.68±0.26 h is detected which is still compatible with a period measured in 2000 (5.7h±1.1h), affected by large uncertainties. Depending on the spectral model the bolometric luminosity is superior or equal to $3*10^{38}$ erg/s and is marginally consistent with a 1.4 M white dwarf accreting at Eddington luminosities. The system was found in outburst in 2016, 2008, 2000 and 1992, suggesting a possible recurrence period of about 8 years.

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Low Mass X-ray Binaries: Not conservative mass transfer and orbital evolution

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Orbital evolution in Low Mass X-ray Binaries is important in order to define the long-term evolution of these systems and their connection with millisecond pulsars through the recycling scenario. Timing analysis of periodic signals in binaries gives information on their orbital period changes on timespan of tens of years. Although this timespan is still short with respect to the secular evolution of a single source, the study of the results obtained from different systems can give some information on their secular evolution. I will review and update results obtained on the orbital period changes observed both in Low Mass X-ray Binaries and in Accreting Millisecond Pulsars, highlighting their long-term behavior as well as peculiarities and discussing the growing evidences for non-conservative mass transfer in these systems.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 206

Smoothed Particle Inference Analysis of Supernova Remnant DEM L71

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Supernova remnants (SNRs) are complex, three-dimensional objects; properly accounting for this complexity when modeling the resulting X-ray emission presents quite a challenge and makes it difficult to accurately characterize the properties of the full SNR volume. We apply for the first time a novel analysis method, Smoothed Particle Inference (SPI), that can be used to study and characterize the structure, dynamics, morphology, and abundances of the entire remnant with a single analysis. We apply the method to XMM-Newton observations of the Type Ia supernova remnant DEM L71. We present histograms and maps showing global properties of the remnant, including temperature, abundances of various elements, abundance ratios, and ionization age. Our analysis confirms the high abundance of Fe within the ejecta of the supernova, which has led to it being typed as a Ia. We demonstrate that the results obtained via this method are consistent with results derived from numerical simulations carried out by us, as well as with previous analyses in the literature. At the same time, we show that despite its regular appearance, the temperature and other parameter maps exhibit highly irregular substructure which is not captured with typical X-ray analysis methods. Interestingly, we find that SPI can be used to decipher the position of the Rayleigh-Taylor unstable contact discontinuity, consistent with that derived from the hydrodynamic simulations. Since the existing X-ray correlations on star-formation rate and stellar mass have been based on a few dozens of galaxies, this much larger sample provides the opportunity to cover the full range of star-formation rate and stellar mass in the local Universe. In addition the large size of the sample enables us to characterize stochastic effects in these scaling relations.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 207

Comparison of spectral models for disc truncation in the hard state of GX 339-4

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We probe models of disc truncation in the hard spectral state of an outburst of the X-ray transient GX 339-4. We test a large number of different models of disc reflection and its relativistic broadening, using two independent sets of codes. We apply it to a Rossi X-ray Timing Explorer spectrum in the rising part of the hard state. Our statistically best model has a physical thermal Comptonization primary continuum, requires the disc to be truncated at a radius larger than or equal to about two ISCO radii for the maximum dimensionless spin, and predicts a disc inclination in agreement with that of the binary. A paper presenting our results has been published in MNRAS (arXiv:1811.09145).

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 208

Hot gas heating via magnetic arms in spiral galaxies?

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In some spiral galaxies the so-called "magnetic arms" have been reported, being interarm areas with significant polarized radio emission that suggests high ordering of the magnetic field. The most prominent example of such a galaxy is NGC 6946.
The nature of these magnetic features is still under debate. One of the possible explanations is the action of reconnection heating that could convert the energy of the magnetic field into thermal energy of the surrounding gas.
We summarize the analysis of the radio and X-ray emission (measured with XMM-Newton) from NGC 6946 and conclude that we might see hints for such reconnection heating (cf. Wezgowiec et al. A&A 585, 3, 2016). A similar analysis is on-going for further galaxies: For one of them, M83, we intend to present preliminary results.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 209

A broad-band analysis of GRS 1758-258 using long-term spectra collected by the INTEGRAL satellite

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GRS 1758−258 is a bright and persistent hard X-ray source discovered in 1990. It is a low mass X-ray binary whose companion star nature remains uncertain due to the system's location close to the galactic centre and the large interstellar absorption. The presence of a double-sided jet points towards a microquasar character of the source. Frequent observations of GRS 1758−258 by the INTEGRAL satellite since 2003 resulted in a large data set in the 3−400 keV band. Using the 22−100 keV spectra summed over each satellite orbit (~3 days) we characterized an overall variability of the source in terms of the flux and spectral slope. Whereas the 22−100 keV flux varies by more than order of magnitude, the photon index remains very stable and concentrated around the value 1.7, with a tendency towards steeper spectra seen only for a few periods of very low flux levels.
For a deeper study of the GRS 1758−258 emission with a physical model we prepared four broad-band (3−400 keV) spectral sets summed according to the level of the orbital flux. These spectra were analyzed with a hybrid Comptonization model allowing us to characterize the plasma region in the system centre. Our results show that the plasma is photon-starved, with relatively low energy of the seed photons. Together with the presence of weak Compton reflection these findings are consistent with the truncated accretion disc model. In addition, we found that the spectra are affected by a strong, local absorption. The three higher flux spectra sets exhibit similar properties. On the other hand, the low flux state emission is less absorbed and strongly reduced above 200 keV.
Finally, we compare our results with those found for other black hole systems, persistent and transient.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER /210

How can a magnet hide its signature line? The case of 4U 1901+03 and 2S 1417-624.

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I present results form our analysis of recent outbursts of the Be X-ray binaries 2S 1417-624 and 4U 1901+03. Both sources enter outbursts only very rarely, but their giant outbursts in 2018 afforded us with the chance to study their accretion behaviour in detail using modern X-ray telescopes such as NuSTAR, NICER, Swift, and Chandra.
For 2S 1417-624 we updated the orbital ephemeris and find a possible super-orbital period of 82d. For 4U 1901+03 we refined the position dramatically using Chandra, which allowed for the identification of the optical companion, i.e., the donor star and the clear classification of the source as a Be X-ray binary.
The spectra of both sources could be well described with typical phenomenological models, and we also applied recently developed physical models. These allowed us to constrain the parameters of the accretion column better. However, neither source showed a Cyclotron Resonant Scattering Feature (CRSF), so a direct measurement of the magnetic moment was not possible. However, from the strong pulsations and spectral results, magnetic fields of the order of 10^{12}G are implied, which often lead to the production of an observable CRSF.
I will put our findings into context with the larger sample of accreting highly magnetised neutron stars, and discuss the lack of a CRSF (despite an implied strong magnetic field) in the context of recent advances in modelling the emission profile of the accretion column.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 211

A Neutron Star Ultra-Compact X-ray Binary Candidate

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We report the discovery of a previously unnoticed X-ray source with a periodic variability at 614.28s. Its spectrum is an absorbed 1.8keV-blackbody with an iron-line feature. It has a L_X about 1.2_*10^{34} $(D/10\ kpc)^2$ erg s^{-1} and has no obvious optical counterpart (fx/fo larger than 1600). We argue it is most likely a neutron-star ultra-compact X-ray binary with the shortest orbital period so far.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 212

Identifying Counterparts for the Pulsar-like Unidentified Hard Gamma-ray Objects

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Using machine learning techniques, we have picked pulsar-like gamma-ray sources from the unidentified objects in the third Catalog of Hard Fermi LAT sources (3FHL). In order to further pinpoint their nature, we have performed a systematic search for the X-ray and optical/IR counterparts of these short-listed 3FHL sources.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 213

X-ray emissions from magnetic polar regions of neutron stars

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Structures of X-ray emitting magnetic polar regions on neutron stars in X-ray pulsars are studied. It is shown that a thin, optically thick, radiation energy dominated, X-ray emitting polar cone appears in each of the polar regions. The height of the polar cone from the neutron-star surface to a standing shock at the top has a large dependence on the accretion rate. When $\dot{M} \simeq 10^{16}$ g s^{-1}, the height is a tenth as low as the neutron star radius. When $\dot{M} \simeq 10^{18}$ g s^{-1}, the height is, however, about 10 times as large as the neutron star radius. Histories of the radiation energy carried with the matter flowing in the polar cone also largely varies with the accretion rate. When $\dot{M}$ is as low as 10^{16} g s^{-1}, the energy is mostly radiated away behind the shock. However, when $\dot{M}$ is as large as 10^{18} g s^{-1} or larger, the energy gain due to the gravity of the neutron star exceeds the energy loss due to photon diffusion in the azimuthal direction of the cone, and a significant amount of energy is advected to the neutron star surface. Then, the radiation energy carried with the flow should accumulate there, and the radiation pressure should overcome the magnetic pressure which has been holding the flow within the cone. As a result, the matter should expand in the tangential direction along the neutron star surface, dragging the magnetic lines of force, and form a mound-like structure. The advected energy to the bottom of the cone should finally be radiated from the surface of the polar mound and the matter should be settled on the stellar surface there. From such configurations, we can expect an X-ray spectrum composed of a multi-color black-body spectrum from the polar cone region and a quasi-single black-body spectrum from the polar mound region. This spectral property agrees with observations. A fairly sharp pencil beam is expected together with a broad fan beam from the polar cone region, while a broad pencil beam from the polar mound region. With these X-ray beam properties, basic patterns in X-ray pulse profiles of X-ray pulsars can be explained too.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 214

X-ray Dust Scattering towards the Galactic Center

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The Galactic Centre (GC) region contains many bright X-ray sources and has a high column density of foreground gas and dust. This suggests that X-ray dust scattering should be ubiquitous and intensive in the GC direction. In this poster, I will show our latest results of discovering significant dust scattering effects for a few bright X-ray sources in the GC. The effects include the existence of an extended X-ray halo around each point-like source, the extra dust scattering opacity imprinted in the X-ray spectrum which causes the spectral disagreement between different instruments and source extraction regions, and the change of apparent variability of XRB due to the smearing of foreground dust scattering. Our studies show that foreground dust scattering is a ubiquitous and important phenomenon that should be considered properly for the spectral-timing study of X-ray sources in the GC. We have created XSPEC models to correct for the dust scattering opacity of a few GC sources.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 215

Neutron Star Population Expected in Galactic Center Region

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We discuss the emission properties of the population of neutron stars that is expected to be present in the innermost parts of the Galactic center. Part of the population of isolated neutron stars should propagate supersonically through denser ionized streams of the Minispiral (Sgr A West), forming bow shocks where particles are accelerated and expected to produce polarized X-ray synchrotron signal. We investigate whether the polarized X-ray emission from Galactic center neutron star bow shocks could be potentially detectable in the framework of future X-ray polarimetry. To this end, we explore the distribution of different interaction modes within the environment and the observability of the resulting bow-shock nebulae.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 216

Deep X-ray Spectral Imaging of the Bow-shock Nebula associated with PSR B1929+10

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We have studied the X-ray bow-shock nebula powered by the old non-recycled pulsar PSR B1929+10 with XMM-Newton data of an effective exposure ~310 ks, which provides the deepest investigation of this system so far. We found the X-ray tail has a length of ~8 arcmin, which is a factor of two longer than that reported in previous study. Evidence for spectral hardening along the tail has been found which suggests certain acceleration processes occur along the nebular emission. With multi-epoch data with a time span > 15 years, we have also placed constraints on the spatial and spectral variabilities of the nebula.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 217

Probing the building blocks of galaxies: sub-galactic scaling relations between X-ray luminosity, SFR and stellar mass

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X-ray emission from star-forming galaxies is a new frontier for probing recent star-formation. X-ray emission, SFR, and stellar mass scaling relations are a unique probe of the connection between X-ray binaries and stellar populations. While most scaling relations are based on studies of the integrated emission of galaxies, very little is known about their validity and scatter in sub-galactic scales. We explored this connection using a sample representative of the star-formation activity in the local Universe (Star-Formation Reference Survey; SFRS) along with a comprehensive set of star-formation (radio, FIR, 24 μ m, 8 μ m, H α , UV, SED fitting) and stellar mass (K-band, 3.6 μ m, SED fitting) indicators, and X-ray observations. We investigated the X-ray luminosity – SFR and X-ray luminosity – stellar mass scaling relations down to sub-galactic scales of ~1 kpc^2. This way we extend these relations to extremely low SFR (~10^{-6} Msol/yr) and stellar mass (~10^6 Msol), reaching the regime of dwarf galaxies. We also quantified their scatter and their dependence on the age of the local stellar populations as inferred from the different age sensitive SFR indicators, and we compare them with predictions from X-ray binary population synthesis models. These results are particularly important for setting the benchmark for the formation of X-ray binaries in vigorous, but low SFR objects such as the numerous dwarf galaxies and galaxies in the early Universe, and for including the X-ray band in panchromatic SED fitting models.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 218

Lessons learned from ULX populations and their environment

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Ultraluminous X-ray Sources (ULXs) are off-nuclear point sources exceeding the Eddington limit for an accreting stellar mass black hole. Their high accretion rates challenge our understanding of accretion physics (e.g. beaming, super-Eddington accretion). The nature of their compact objects and their formation channels are of great interest for the single/binary stellar evolution and the nature of the sources dominating the X-ray output of galaxies. Additionally, as potential progenitors of NS/BH mergers they offer an observational window to the past of gravitational wave sources.
We compile a catalog of galaxies in the local Universe (< 200 Mpc) and using multi-wavelength archival data we estimate their distance, star formation rate, stellar mass, metallicity and AGN content. By cross-matching the galaxy sample with the Chandra Source Catalog 2.0, we construct the largest up-to-date census of ULX populations. We probe the rate of ULXs in early- and late-type galaxies and its scaling with stellar mass (one ULX per ~$4.5{*}10^{11}$ M_{sun}) and star formation rate (~0.6 ULXs per M_{sun} yr^{-1}). Finally, we find a negative correlation between the formation rate of ULXs and the metallicity of their host galaxies in the $8 < 12 + \log(O/H) < 9$ range.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 219

The X-ray emission from hot subdwarf stars

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In the last decade the high throughput and spectral resolution of the *XMM-Newton* and *Chandra* X-ray telescopes has allowed us to investigate the X-ray emission from hot subdwarf stars. Up to now, we have detected in X-rays five sdO stars. All of them show intrinsic X-ray emission and their spectrum can be described with the sum of two or three thermal-plasma components, as in the case of normal O-type stars. Therefore, the X-ray emission seems to originate from shock instabilities in the wind. These results show that the X-ray observation of hot subdwarf stars is essential for understanding their properties.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 220

The properties of the soft excess in the transient X-ray binary pulsars of the Small Magellanic Cloud

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The spectrum of X-ray accreting pulsars is usually well described by a hard power-law model, although several sources show also a significant soft excess at low energies. This feature is essential to investigate the physical processes on-going in accreting sources and can be ontained only through high-quality spectral data for such pulsars. To this aim, the best targets to observe are the transient accreting pulsars in the Small Magellanic Cloud: they can reach luminosities up to 10^{38} erg s^{-1} during their outbursts and, because of the low Galactic interstellar absorption in the SMC direction, they can provide high count-statistics spectra at low energies. In the last five years, we have observed with *XMM-Newton* large outbursts of four different pulsars in the SMC. Thanks to the high throughput and spectral resolution of *XMM-Newton*, these observations allowed us to investigate very deeply their spectral and timing properties at soft X-ray energies. In all cases, we detected a pulsating and low-temperature blackbody component, which can be ascribed to the reprocessing of the primary X-ray emission by the optically thick material at the inner edge of the accretion disk. Moreover, in one source we observed also a steady, hot thermal plasma component, which is very likely due to a diffuse collisionally-heated gas far from the accretion region. Finally, in all sources the RGS spectrum shows several narrow emission and absorption features: they cannot be attributed to the thermal plasma, but may be related to the photo-ionized matter located around the accreting source.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 221

XMM-Newton Survey of Magellanic Bridge

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Along with available optical data of the Magellanic Bridge (the interconnecting region between the Small & Large Magellanic Cloud), we aim to characterise the X-ray binary population as a function of the local stellar population (in terms of age, metallicity, and stellar density) in the Bridge. Gardiner & Noguchi (1996) suggests that closest approach between Small & Large Magellanic Cloud, as evidenced by dramatic phase shift in star formation, occurred approximately ~200 Myr ago. During the approach, gas had been tidally stripped (most likely from the Small Magellanic Cloud) into the interconnecting Bridge. According to models of star formation history (Harris 2007), alongside optical surveys of the Bridge, there is strong evidence to suggest that the young, low metallicity stellar population formed in situ, rather than being tidally stripped from either Magellanic Cloud. Studying this region enables for a closer look at galaxy mergers, as well as how this environment (gas density, metallically) affects star formation. Thus the Magellanic Bridge gives us a window into galaxy interaction mechanics, as it contains resolvable X-ray and optical sources. X-ray data is obtained through the XMM-Newton from three separate fields, located near the Western Bridge, which coincides with available optical data. X-ray binary candidates will be followed up with spectroscopic analysis, using the 1.9m telescope located in Sutherland.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 222

Searching for X-ray emission from an electron/positron pair halo with current generation and next generation X-ray telescopes

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An electron/positron pair halo is the electromagnetic cascade generated under extragalactic magnetic field when very high energy γ-rays, particularly from blazar, interact with the extragalactic background light and/or the cosmic microwave background forming the pairs of electron/positron and further lower energy γ-rays. These result in an extended emission of the γ-rays enclosing the host blazar, i.e. halo. The search for the halo emission has been attempted primarily in the γ-rays regime and no detection has been claimed to date. Indeed, if such an halo presents in a sufficiently strong magnetic field, the X-ray light could be also generated via synchrotron emission process, providing another opportunity for searching the halo. In this work, we aim to test whether the X-ray emission from the halo would be detected by the current generation and next generation X-ray telescopes: i.e. *XMM-Newton* and *Athena*, respectively. The Monte Carlo technique is used to simulate the X-ray emissions of the halo at difference initial conditions such as different energy distributions of the seed γ-rays photons and different levels of magnetic field. The possibility of detecting the halo emission by the X-ray telescopes is then determined using the response matrix and ancillary response files provided on the telescope webpages. In this presentation, we will show whether the halo emission would be detected by the X-ray telescopes? We will also discuss the range of physical parameters of the halo which make the halo emission statistically detectable.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 223

X-Ray Census of Millisecond Pulsars in the Galactic Field

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We have conducted a systematic survey for the X-ray properties of millisecond pulsars (MSPs). Currently, there are 47 MSPs with confirmed X-ray detections. We have also placed the upper limits for the X-ray emission from the other 36 MSPs by using the archival data. We have normalized their X-ray luminosities L_X and their effective photon indices Γ into a homogeneous data set, which enables us to carry out a detailed statistical analysis. Based on our censored sample, we report a relation of $Lx\ 10^{31.05}(\dot{E}/10^{35})^{1.31} ergs^{-1}$ (2-10 keV) for the MSPs. The inferred X-ray conversion efficiency is found to be lower than the previously reported estimate that could be affected by se- lection bias. L x also correlates/anti-correlates with the magnetic field strength at the light cylinder B LC/characteristic age τ . On the other hand, there is no correlation between L x and their surface magnetic field strength B s . We have further divided the sample into four classes: (i) black-widows,
(ii) redbacks, (iii) isolated MSPs, and (iv) other MSP binaries, and compare the properties among them. We noted that while the rotational parameters and the orbital periods of redbacks and black-widows are similar, L x of redbacks are significantly higher than those of black-widows in the 2-10 keV band. Also the Γ of redbacks are apparently smaller than those of black-widows, which indicates that the X-ray emission of redbacks are harder than that of black-widows. This can be explained by the different contribution of intrabinary shocks in the X-ray emission of these two classes.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 224

A joint NICER and XMM-Newton view of the "Magnificent" thermally emitting X-ray Isolated Neutron Star RX J1605.3+3249

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Thermally emitting X-ray isolated neutron stars represent excellent targets for testing cooling sur- face emission and atmosphere models, which are used to infer physical parameters of the neutron star. Among the seven known members of this class, RX J1605.3+3249 is the only one that still lacks confirmation of its spin period. Here we analyze NICER and XMM-Newton observations of RX J1605.3+3249, in order to address its timing and spectral behavior. Contrary to a previous tentative detection, but in agreement with the recent work by Pires et al. (2019),
we find no significant pulsation with pulsed fraction higher than 1.3% (3 sigma) for periods above 150 ms. We also find a limit of 2.6% for periods above 2 ms, despite searches in different energy bands. The X-ray spectrum can be fit by either a double-blackbody model or by a single-temperature mag- netized atmosphere model, both modified by a Gaussian absorption line at ~0.44 keV. The origin of the absorption feature as a proton cyclotron line or as an atomic transition in the neutron star atmosphere is discussed. The predictions of the best-fit X-ray models extended to IR, optical and UV bands are compared with archival data. Our results are interpreted in the framework of a fallback disk scenario.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 225

10 years of the Fermi/GBM Pulsar Project

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We review 10 years of continuous monitoring of accretion-powered X-ray pulsars with the Gamma-ray Burst Monitor (GBM), the softer-energy all-sky monitoring instrument aboard the Fermi Gamma-ray Space Telescope. The excellent combination of timing, spectral and full-sky coverage capabilities of GBM make it a unique instrument for the study of those objects. After discussing our analysis approach we present the most interesting results for individual sources.
Over 10 years of operation, GBM helped to characterize spin histories, outbursts and torque behaviors of transient and persistent sources, deriving ephemeris and orbital solutions for a variety of sources with high precision. This, in turn, makes possible the study of binary systems, as well as the long term pulsars spin histories, two elements that are crucial to understanding the accretion processes onto magnetized neutron stars. Recently, GBM played a fundamental role in discovering and characterizing the first Galactic Ultraluminous X-ray Pulsar, Swift J0243.6+6124. Today, after an outburst that took ~150 days, this unique source is still active and GBM keeps revealing more and more of its behavior.
This is emblematic of GBM capabilities and its exclusive scientific return.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 226

Extended X-ray Emission Around Wolf-Rayet Stars: Circumstellar Structure and Evolution

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We discuss the hot gas detected in X-rays around Galactic Wolf-Rayet stars. In particular, we discuss the XMM-Newton detection of extended X-ray emission from the Wolf-Rayet ring nebula NGC 3199, unveiling the powerful effect of the fast wind from WR 18. The X-ray emission is brighter in the region southeast of the star and an analysis of the spectral properties of the X-ray emission reveals abundance variations: (i) regions close to the optical arc present nitrogen-rich gas enhanced by the stellar wind from WR 18 and (ii) gas at the eastern region exhibits abundances close to those reported for the nebular abundances derived from optical studies, which is a signature of an efficient mixing of the nebular material with the stellar wind. The dominant plasma temperature and electron density are estimated to be $T \approx 1.2 \times 10^6$ K and $n_e = 0.3$ cm^{-3} with an X-ray luminosity in the 0.3-3.0 keV energy range of $L_X = 2.6 \times 10^{34}$ erg s^{-1}, which is not atypical of hot bubbles around massive stars, but which is lower than expected from standard wind-blown bubble theory. We discuss the implications in particular with respect to nebulae around apparent runaway Galactic Wolf-Rayet stars.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 227

The Weirdest Objects in the Chandra Source Catalog 2.0. A Machine Learning Approach

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The version 2.0 of the Chandra Source Catalog (CSC2) offers an unprecedented opportunity for serendipitous discovery. Out of $\sim 315,000$ CSC2 sources, two thirds are detected for the first time in X-rays, while a significant fraction of the remaining objects has never been studied in detail. CSC2 sources are characterized in terms of their X-ray fluxes, hardness ratios, variability, and spectral properties, and include a large variety of X-ray phenomena, from young stars, to compact binaries. Our preliminary investigations show that the CSC2 also includes "weird" sources that could be either examples of these known classes, observed in rare or unknown stages of their evolution, or even instances of previously unidentified X-ray source types. We present a machine learning method to maximize the potential for discovery of CSC2, by exploring the catalog using an anomaly detection algorithm, the unsupervised random forest (URF), and report the most unusual sources in the X-ray universe resulting from this search. We identify several rare X-rays sources, including the rediscovery of a γ-ray emitting nova, an ultraluminous stellar-mass black hole, and many more interesting sources that are currently unclassified and that could potentially indicate new types of X-ray sources. We show how our method is a robust and straightforward way to select candidates of unknown class for multi-wavelength and spectroscopic follow up. Although applied to the CSC2, this method is easily adapted for other X-ray catalogs, such as the XMM-Newton Source Catalog.

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Diving into the whirlpool – understanding accretion in High-Mass X-ray Binaries with Vela X-1

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The eclipsing high mass X-ray binary Vela X-1 consists of an accreting X-ray pulsar orbiting an early type supergiant with an orbital period of ~ 9 days. It was discovered as an X-ray source by the Uhuru satellite and it has been observed since then by every X-ray observatory. Due to its brightness and variability as well as the large observational archives, Vela X-1 is the Rosetta stone for studies of wind accretion onto neutron stars.
We discuss the X-ray observational properties of the system in conjunction with the supergiant properties to test recent accretion models in high mass X-ray binaries, ranging from detailed descriptions of the wind acceleration (e.g., Sander et al. 2018) to modelling of the structure of the flow of matter close to the neutron star (e.g., EL Mellah, Keppens & Sundqvist 2018). We report new results on the impact of the wind clumpiness on the X-ray time variability and how the revised downwards wind speed implies dramatic consequences for the accretion process such as the formation of a wind-captured disc beyond the neutron star magnetosphere. Such a structure remains to be observed but its indirect signatures through jets or the torques it applies on the neutron star could well be within our observational grasp.

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X-ray Reverberation Mass Measurement of Cygnus X-1

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Both galactic and supermassive black holes display characteristic features in their energy spectra, including an Fe Kα line and a Compton hump, that result from reprocessing of hard X-ray photons by the accretion disk. This reflected emission provides a probe of the innermost region of the accretion disk through general relativistic distortions to the line profile. However, these spectral distortions are insensitive to black hole mass, since they depend on disk geometry in units of gravitational radii. Measuring the reverberation lag resulting from the difference in path length between direct and reflected emission gives a measure of absolute photon path length differences. Therefore the length of the gravitational radius can be calibrated by a combined spectral-timing analysis, providing a means to measure black hole mass. I will present the application of our new reverberation model to RXTE data from the black hole X-ray binary Cygnus X-1. We jointly fit the time-averaged X-ray spectrum and the real and imaginary parts of the cross-spectrum as a function of energy for a range of Fourier frequencies, in order to constrain the mass of the black hole. I will show how introducing a radial ionisation profile in the disk changes our results and I will compare our reverberation mass measurement with the dynamical mass measurement of Cygnus X-1.

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Discussion on the orbital ephemeris of the ADC source X 1822-371

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The low mass X-ray binary systems (LMXBs) are composed of an accreting neutron star (NS) and a late-type companion (CS). They show very interesting spectral and timing characteristics. We distinguish some typical features in their light curve, like eclipses and dips, depending on the value of the inclination angle between the line of sight with respect to the perpendicular to the orbital plan of the system.
Through a timing analysis of their occurrence we can estimate this period and all the other orbital parameters which define the secular evolution of the system.
The source X 1822-371 is an eclipsing compact binary system with a period close to 5.57 hrs and an orbital period derivative $\dot{P}_{\rm orb}$ of $1.51(7)*10^{-10}$ s/s. The very large value of $\dot{P}_{\rm orb}$ is compatible with a super-Eddington mass transfer rate from the companion star, as suggested by X-ray and optical data.
We estimated the number of orbital cycles and the delays of our eclipse arrival times spanning 40 yrs. Fitting the delays, we found an orbital period $P_{\rm orb} = 5.57062957(20)$ hrs and a $\dot{P}_{\rm orb}$ value of $1.475(54)\ 10^{-10}$ s/s.
The obtained results confirm the scenario of a supper-Eddington mass transfer rate; indeed, we can exclude that the observed delays of the eclipse arrival times could be caused by a gravitational coupling between the orbit and the change in the oblateness of the companion star.

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A young, contracting white dwarf in the peculiar X-ray binary HD49798/RX J0648.0–4418

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HD49798/RX J0648.0-4418 is the only known binary composed of a hot subdwarf star and an accreting neutron star or white dwarf. We discovered that the compact objects has a spin period of 13.2 s and is spinning up at a rate of $2*10^{-15}$ s/s.
The precise distance of 508 pc recently measured with Gaia strongly disfavours the possibility that the pulsar be a neutron star. On the other hand, the accretion rate occurring in this system is too small to cause such a rapid spin-up in a white dwarf. We show that the spin-up is instead well explained by the decreasing moment of inertia of a massive white dwarf with an age of only ~2 Myrs, still in the early contracting phase. Radial contraction in the early phase of white dwarf evolution is predicted by the theoretical models, but it has never been observed before.
Binary evolution computations show that several hundreds of systems with a white dwarf orbiting a hot subdwarf similar to HD49798 exist in the Galaxy and many of them can be revealed by future X-ray missions.

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Detailed study of X-ray binary system M33 X-6 behaviour with XMM-Newton

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We are looking for changes of spectral states of X-ray binary system X-6 in Galaxy M33 and similarities with other known Z-sources. In our previous work (Nikolaeva et al., 2018) we showed that there is a neutron star as a compact object. And spectrum shape looks like the spectrum in one of the spectral states of Z-source (neutron star with low magnetic field) RX J0042.6+4115 in M31 – the first extragalactic Z-source found, others have been found in our Galaxy. Using 28 datasets of XMM-Newton data, we fitted spectrum with different models which describes emission from corona, boundary layer, and thermal disk, found system period and plotted HID diagram.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 233

NICER measurements of variability time scales i supersoft X-ray sources.

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We present NICER observations in which the modulations of the X-ray flux in two supersoft X-ray sources were measured with unprecedented data quality. We observed two luminous targets, CAL 83 in the LMC with its intriguing 67 seconds periodicity, and MR Vel in the Galaxy. We discuss the results in the context of the structure and evolution of the two binaries, especially focusing on what they reveal on shell nuclear burning.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 234

Feeding neutron stars and black holes by fresh stellar winds

Author(s): Lidia Oskinova; Rainer Hainich ; Wolf-Rainer Hamann

High-mass X-ray binaries (HMXB) represent an important evolutionary stage in lives of many massive stars. Significant fraction of HMXBs consists of a neutron star or a black hole deeply embedded in massive donor star wind and accreting its material. We have conducted a survey of HMXBs with the Hubble Space Telescope, and determined stellar wind parameters from measured UV and optical spectra. I will briefly review the main results of this observing campaign which question the leading models explaining different sub-types of HMXBs. I will also briefly review what recent X-ray observations of HMXBs reveal about the structure of donor stellar winds, stellar wind clumping, and large scale corotating interaction regions. Finally, new types of HMXBs with unusual X-ray properties will be presented. These exotic objects may represent still missing links in the evolution of massive binaries towards double degenerate binaries.

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Timing and Spectral Analysis of Black Hole Candidate X-Ray Binary MAXI J1535-571 from NICER Observations

Author(s): Özgür Can Özüdoğru[1]

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This Bachelor's Thesis is mainly focused on Neutron Star Inner Composition ExploreR (NICER) Observations of MAXI (The Monitor of All-Sky X-Ray Image) J1535-571, a Galactic Black Hole Candidate with an accompanying Star. Research conducted by J.M. Miller et al. 2018 and A. L. Stevens et al. 2018 were followed in order to acquire similar results, that is; confirming the existence of relativistic accretion disk reflection and line broadening at the Fe K line. This line broadening effect allowed the spin parameter(a) value to be measured as a=0.998(5). Fitting results of the models used during the spectral fitting indicate that the disk of MAXI J1535-571 may be warped.
Afterwards, the timing of the source from 3 NICER Observations was made and three power spectra that indicate the existence of one peak which resembles Quasi Periodic Oscillation(QPO) of the source around 6 Hz on the power density spectra were acquired. Results also indicate that this QPO seems to be shifting in frequency as time passes.

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The 2017 Outburst of Swift J1357.2-0933: Variable period blue dips with a hot, dense HeII wind

Author(s): John A. Paice[1]

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Quasi-simultaneous optical (ULTRACAM/NTT, SALT), X-ray (NuSTAR, XRT/Swift) and radio(ATCA) observations of the short P , high latitude LMXB transient, Swift J1357.2-0933 during its 2017 outburst have revealed remarkable additional properties. In addition to confirming the variable frequency optical dipping seen during its 2011 discovery outburst, we also find: (1) the dip shape is consistent with partial disc occultations, (2) the source becomes significantly bluer during these dips, indicating an unusual geometry compared to other LMXB dippers, (3) there is no X-ray response to the optical dips, (4) HeII and Balmer absorption is present only during the dips, and is blue-shifted by ~600 km s^{-1}. These spectral features imply a very hot (Te ~40,000K), dense ($n \sim 10^{13-14} cm^{-3}$) outflowing wind driven by a central LX ≥1036 erg s^{-1}. Its periodic visibility implies a very high viewing inclination, and a warped inner disc structure that moves out during the outburst. This is also consistent with its low observed FX/Fopt ratio, implying that it is an Accretion Disc Corona (ADC) source, and not a VFXT (very faint X-ray transient).
This poster represents a summary of results presented in Paice et al 2019 (P19) and Charles et al 2019 (Ch19) – all figures are taken from these papers.

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Phase Lags on High Frequency Quasi-Periodic Oscillations in the transient source XTE 1701-462

Author(s): Valentina Peirano Bastías[1]

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Variability in the emission of neutron stars and black holes X-ray binaries is a very puzzling field of study: the nature of the mechanism that produces the oscillations is still a subject of debate and unravelling this mystery could bring us closer to understand the physics in extreme environments like the ones around compact objects. Using Fourier techniques in X-ray timing analysis, we study archival RXTE observations of the unique transient neutron star X-ray binary: XTE 1701-462. These observations show the source transitioning from Z state into atoll state, while kHz QPOs (quasi-periodic oscillations at kHz Fourier frequencies) are present in its light curve. We analyse the power and lag spectra of each observation to measure the time delay between the hard and soft X-ray emission of the source around the QPOs frequencies. Studying this particular source, using X-ray timing techniques, could give us an important understanding into the differences between atoll and Z sources, especially regarding the different timing behaviour (strength and intensity of the variability) that we see in them. Preliminary results of this analysis will be shown in the poster.

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Monitoring a variable ULX in the Circinus Galaxy

Author(s): Sean Pike

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We present the results of an ongoing monitoring campaign of Circinus ULX5 using the Neil Gehrels *Swift* Observatory. The source shows significant variability, with clear high and low states, accompanied by variability in its spectral parameters. We discuss the physical mechanisms that may be responsible for the observed variability, including superorbital modulation due to a warped accretion disk and the "propeller effect" in which accretion is choked by the magnetic field of the accreting compact object. Further, we consider the implications of the observed variability in regards to the nature of the compact accretor, comparing our observations to those of known black hole and neutron star X-ray binaries.

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Understanding super-Eddington accretion through winds in ultraluminous X-ray sources

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Among the most important and debatable problems in astrophysics and cosmology is the formation of supermassive black holes. The detection of fully-grown supermassive black holes in active galactic nuclei at high redshift, when the Universe was young, challenges the theories of black holes growth, requiring long periods of high accretion, most likely above the Eddington limit. This is a focus of the next generation large missions, such as JWST and ATHENA, but the most distant supermassive black holes will be difficult to probe even with these advanced observatories. Ultraluminous X-ray sources (ULXs) are bright objects with X-ray luminosities between 10^{39-41} erg/s and can be found in nearby galaxies. Today we know that the vast majority of this complex class consists of stellar-mass black holes or neutron stars accreting at or above the Eddington limit. This was made possible by the discovery of coherent pulsations and cyclotron lines in some ULXs, indicating that at least a fraction of them hosts neutron stars as compact objects and, finally, the discovery of powerful winds as predicted by theoretical models of super-Eddington accreting black holes and neutron stars. In particular, the presence of both pulsations and winds in a pulsating ULX supports the existence of hybrid configurations where thick disks and radiatively-driven winds survive despite the opponent strong magnetic pressure. ULX winds carry a huge amount of power owing to their mildly relativistic speeds (~0.2c) and are able to significantly affect the surrounding medium such as regulating the ionization state and brightness of ULX super bubbles. The winds substantially limit the amount of matter that can reach the central accretor, which slows down its growth and extends its lifetime – in the case of an accreting neutron star. The study of ULX winds is therefore quintessential to understand 1) how much and how fast can matter be accreted by black holes and 2) how strong is their feedback onto the surrounding medium in the regime of high accretion rate such as for quasars and supermassive black holes at their peak of growth. In this talk I will provide an overview on this vast phenomenology and its state-of-art, focusing on recent discoveries of outflows in ULXs and their characteristics.

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A Chandra Legacy Observation of N132D

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N132D is the most X-ray luminous supernova remnant (SNR) in the Local Group with a luminosity of L_x (0.3-10.0 keV) = 1.0×10^{38} ergs/s. Given its location in the Large Magellanic Cloud, it is a prime target for detailed X-ray studies with the Chandra X-ray Observatory. The existing 87 ks Chandra observation of N132D has revealed the complicated spatial and spectral structure of this SNR, but the depth of this observation limits the spatial scale on which detailed spectroscopy may be performed. We successfully proposed for a Chandra legacy observation (900 ks) of N132D that will permit an unprecedented look at the spatial distribution of iron and other heavy elements in the ejecta from this prototypical core-collapse supernova. Combined with supporting multiwavelength data (from radio to gamma rays), these data will inform many areas of active research, including late stages of massive star evolution, explosion mechanisms and dynamics, and physical mechanisms for the interaction of shocks with molecular clouds and cavities. As models of massive stars and their supernovae improve, observations such as the one proposed are the only way to constrain models of massive stars and their supernovae. We will present preliminary results from the observations performed to date.

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Probing the tenuous interstellar dust medium using soft X-ray absorption features

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The interstellar dust permeates our Galaxy and plays a crucial role in star formation processes. It can control the temperature of the ISM and it is the catalyst for the formation of complex molecules. However, the exact chemical composition of dust grains is not yet fully understood. Insights can be gained by combining X-ray observations and laboratory measurements. High resolution X-ray spectroscopy of bright background sources gives the ideal workbench to study the chemical composition of dust in diffuse regions of the ISM through the absorption features of dust and gas. In particular, here we focus on the Fe L and O K absorption edges, two among the most abundant elements that determine the chemical composition of dust grains. For our spectral modelling we obtained new laboratory measurements of dust scattering and calculated the corresponding cross sections for samples of different chemical composition. The measurements were acquired with the Electron Energy Loss Spectrometer in Cadiz. Lastly, we examine systematic divergencies in the atomic (gaseous phase) data of the oxygen edge using different X-ray atomic databases.

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Accretion disk atmosphere of X-ray binaries: The case of EXO 0748-676

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X-ray binaries exhibit ionized emission from an extended disk atmosphere that surrounds the accretion disk. However, the nature and exact geometry of the atmosphere are not fully understood. Here, I will present results from our recently published paper (Psaradaki et al. 2018) about the case study of the bright low-mass X-ray binary EXO 0748-676. In this work we carry out high-resolution X-ray spectroscopy of archival XMM-Newton observations in order to probe the accretion disk atmosphere. We model the high-resolution spectrum obtained when the compact object is eclipsed by the companion star. This unique situation enables us to study the emission lines that come only from the disk atmosphere of the source and gain new insights into its physical structure.
The emission line spectrum reveals two photoionized gas components with different physical characteristics. We propose a scenario where the high ionization component constitutes an extended upper atmosphere of the accretion disk. The lower ionization component may instead be a clumpy gas created by the accretion stream from the companion star impacting the disk.

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CG X-1: an eclipsing Wolf-Rayet ULX in the Circinus Galaxy

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Compact Wolf–Rayet X–ray binaries with orbital periods of less than a day are a rare class of sources, probing a short–lived (few 10^5 yr) but key evolutionary stage of binary systems. They emerge from a common envelope phase and (if they survive the second SN explosion) they form double compact objects that can merge via gravitational decay in less than a Gyr. We studied the candidate Wolf–Rayet X–ray binary CG X–1 in the Circinus galaxy, using 20 years of Chandra and XMM–Newton data. CG X–1 is an eclipsing source and one of the most luminous ULXs in the local universe (peak $L_X = 3\times10^{40}$ erg/s at a distance of 4.2 Mpc). We phase connected the lightcurves in the archival data and derived a period of (25,970.0 +/– 0.1) s and a period derivative $\dot{P}/P = (10.2 +/- 4.6)\times10^{-7}$ yr^{-1}. The intriguing dipping and eclipsing behavior of CG X–1 is different from the orbital modulations seen in other classes of X–ray binaries. We suggest that such lightcurves are a defining property of this class of super–Eddington sources, in which both the primary and the secondary launch dense, fast outflows with similar kinetic power. We propose a model for the asymmetric dips and occultations, based on partial covering by Compton–thick clouds. We speculate that the main occulting material is dense, shocked wind between black hole and donor star, and in a bow shock ahead of the black hole.

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Progress in timing properties of compact X-ray binaries by Sight-HXMT observation

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The Hard X–ray Modulation Telescope (Insight–HXMT) is China's first astronomical satellite and launched on 15th June 2017. Thanks to its large effective area at high energy detector (up to 250 keV), some important achievements in X–ray binaries have been obtained. Here we only show a few interesting timing results: the high energy QPO up to 250 keV is discovered in black hole transient MAXI J1820+070, the kHz QPO in Sco X–1 extend to > 30keV, and so on. More and detail results can see the poster by Huang and the reports by S N Zhang and S Zhang in this conference.

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Relativistic Reflection Signatures Detected from the Galactic Microquasar GRS 1758-258

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GRS 1758−258 is a persistent X−ray source, located in the Galactic center, and considered to be an accreting stellar mass black hole on the basis of its hard X−ray emission and similarities to Cygnus X−1. The additional detection of relativistic jets from GRS 1758−258 is of great interest given the potential to test theoretical accretion in/outflow models. However, prior observations of GRS 1758− 258 have revealed a simple power−law dominated hard X−ray spectrum. Herein, we present the results of a new 50 ks observation with NuSTAR. The source is detected across the broad NuSTAR bandpass and reveals, for the first time, the characteristic features of relativistic reflection from the inner accretion disk at a source luminosity of ~1% Eddington. Modeling the spectra with the relativistic reflection code relxill, we find the black hole to be rapidly rotating, with a* > 0.8.

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Data Mining and High Performance Computing in High-energy Astrophysics: the case of the Extragalactic X-ray pulsars.

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The use of Big Data techniques and High Performance Computing (HPC) allows us to explore High−energy data archives in new ways, exploring and extracting new information buried in the fast growing volume of astrophysical data. I will talk about our mixed Data Mining and HPC approach and how it has allowed us to uncover a new population of Extragalactic Neutron Stars (NS), most of them − Ultra Luminous X−Ray sources (ULXs), a class believed to host intermediate−mass black holes. The discovery of these pulsating ULXs (PULXs), NS at strongly Super−Eddington luminosities, has change radically our views in the ULX population in general. I will describe these discoveries and their main implications and the future direction of our work in this field.

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Spin-Reversals in the X-ray Binary Pulsar OAO 1657-415

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OAO 1657−415 is an X−ray binary pulsar that exhibited a long−term spin−up trend with short−term torque reversals in the past. In this work we present over 10 years of data from Fermi/GBM and Swift/BAT to study the long−term spin behavior and the torque−flux relation of this source, using current accretion torque models. The frequency history shows that the source is no longer on a spin−up trend but has settled in an equilibrium spin period of about 27 mHz with short−term spin−reversals. The analysis of the torque−flux relation shows a correlation when the source is spinning up, indicating that matter is likely accreted from a stable accretion disk. The observations during the spin−down of the pulsar could be explained by accretion from a retrograde disk or a sub−Keplarian behavior of the disk. The accretion process in this regime, however, remains elusive. A domain where the torque is close to zero has also been observed with a highly scattered flux, which could be explained by direct accretion from the stellar wind of the companion.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 248

What can we learn from ULXs variability?

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ULXs are extra−galactic X−ray binaries with X−ray luminosities in excess of 10^{39} erg s^{-1}, the Eddington limit for accretion onto a ~10M_{sun} object. They are composed of a compact object and a companion star. The nature of the compact object is still not clear: it could be a neutron star, a stellar mass black hole or an intermediate mass black hole. Since measuring the mass is not feasible in most cases, we are studying different approaches in order to gain insight onto the nature of these elusive objects. In particular I will address the variability of ULXs as a class, both in brightness and spectral shape. My work focuses on the study of variability on timescales from weeks to years.
I will show the result from the analysis of all the X−ray data of the Cartwheel galaxy, a spectacular example of collisional ring galaxy which hosts the largest number of ULXs for a single galaxy. I will also present the long term variability characteristics of a sample of ULXs observed by Swift.
I will discuss my findings in the context of black hole and neutron star variability.

COMPACT AND DIFFUSE SOURCES IN GALAXIES & IN THE GALACTIC CENTER / 249

Distribution of Matter in and around Galaxies

Author(s): Norbert S. Schulz[1]

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The chemical evolution of the Universe embraces aspects that reach deep into modern astrophysics and cosmology. We want to know how present and past matter is affected by various levels and types of nucleo-synthesis and stellar evolution. Three major categories include the study of premordial star and black hole formation, the embedded evolution of the intergalactic medium (IGM), and the status and evolution of stars and the interstellar medium (ISM) in galaxies. A fourth category relates to our understanding of dark matter in relation with these three categories.
The X-ray band is particularly sensitive to K- and L-shell absorption and scattering from high abundant elements like C, N, O, Ne, Mg, Si, S, Ar, Ca, Fe, and Ni. Like the Lyman alpha forest in the optical band, absorbers in the IGM produce an X-ray line forest along the line of sight in the X-ray spectrum of a background quasar.
Similary bright X-ray sources within galaxies and the Milky Way produce a continuum, which is being absorbed by elements in various phases of the ISM.
Since its emergence, high resolution X-ray spectroscopy has greatly impacted studies of properties of the gas phases of the ISM of the Milky Way. greatly impacted studies of properties of the gas phases in the interstellar medium (ISM) of the Milky Way and warm absorber phases in galaxies. At the forefront we have the high energy transition grating spectrometer (HETGS) with its unprecedented spectral resolution onboard the Chandra X-Ray Observatory. Resolving the O K, Ne K, and to some extent the Fe L edge structures reveal how X-ray spectra are are affected by absorption and exposed the physics of the cold, warm, ionized and hot phases of the ISM. Studies of higher Z edges such as Mg K, Si K, S K and to a large extent Fe L in contrast indicate dominant dust signatures in the edge structure. In this presentation we review and summarize the efforts made by observations with the HETGS so far and include recent findings of multiple edge functions, near edge absorption excesses from silicates in dust form, contributions from X-ray scattering optical depths as well a the presence of variable warm absorbers from silicon and iron. These studies also reveal that many of the details we observe remain unchallenged by current capabilites.
In this respect we also show how future observatories such as Athena, XARM, and possibly Arcus and Lynx will lead us to a much broader understanding of the categories defining the state and distribution of matter in and around galaxies.

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Peculiar outbursts of an ultra luminous source likely signs of an aperiodic disc-wind

Author(s): Holger Stiele

Co-author(s): Albert Kong[1]

[1] *National Tsing Hua University*

The ultra luminous X-ray source XMMU 122939.7+075333 is located in the metal rich globular cluster RZ 2109 in the massive Virgo elliptical galaxy NGC 4472 (M49). Previous studies showed that this ultra luminous source varies between bright and faint phases on timescales of just a few hours. Here, we present the discovery of two peculiar X-ray bursting events that last for about 8 and 3.5 hours separated by about 3 days. It is the first time that such a recurring X-ray burst-like behaviour has been observed. We show that type-I X-ray bursts or super bursts as well as outburst scenarios requiring a young stellar object are highly unlikely explanations for the observed light curve. Thus only an aperiodic disc-wind scenario driven by hyper-Eddington accretion remains as a viable explanation for this new type of X-ray flaring activities.

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Variability studies of black hole X-ray binaries with NICER

Author(s): Holger Stiele

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NICER's X-ray Timing Instrument allows investigating short-term variability of compact objects in the soft (0.2-12 keV) X-ray band. We used publicly available NICER monitoring data of black hole X-ray binary candidates, to investigate their short-term variability and follow it throughout the outburst. Black hole X-ray binaries are known to show a certain variability feature, called quasi-periodic oscillation, which can occur in different flavours depending on the state the source is in. We compare our NICER results to those obtained from other X-ray instruments, present our findings on quasi-periodic oscillations and covariance spectra, and discuss implications.

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Accreting magnetars

Author(s): Jose Miguel Torrejon[1]

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Among High Mass X-ray Binaries, accreting from the stellar wind of its massive OB star companions, there is a growing number of systems in which a magnetized neutron star harboring magnetic fields beyond the quantum critical limit ($B>10^{13}$ G) is required to explain the observational properties. Such Accreting Magnetars have been invoked to explain Supergiant Fast X-ray Transients and, more recently, ULXs. However, their existence would challenge the current theories on NS structure and evolution and how NS are born. In this talk I would present recent research on some accreting magnetar candidates, their observed properties, what they tell us about the circumsource environment and the current state of the subject. Prospects for observations with future X-ray missions will also be discussed.

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Effects of the Dust Scattering Halo of 1E 1740.7-2942 on it's timing properties during the hard state

Author(s): Ozan Toyran[1]

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We investigated the effects of dust scattering halo (DSH) of the high N_H source (~10^{23} cm^{-2}) 1E 1740.7-2942 on it's timing properties during the hard state. We observed the source simultaneously using XMM-Newton and RXTE for ~20 ks. Our results show that the observed fractional rms amplitude of variability is low compared to the typical values for the GBH sources in the hard state. Imaging analysis showed that the DSH is still present even in the EPIC-PN's "Small Window Mode". We also report that there is a molecular cloud with VLSR=-152.4 km s^{-1} in the line-of-sight of the source. Finally, we employed an empirical correction method to obtain the "intrinsic" power spectra and rms amplitude of variability using XMM-Newton and RXTE data together.

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A search for intermediate-mass black holes in the Swift-XRT catalog

Author(s): Hugo Tranin[1] ; Olivier Godet[1]

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Intermediate-mass black holes (IMBH) are thought to be the building blocks of supermassive black holes that are found at the center of massive galaxies, but evidence for their existence is elusive. We performed a search for IMBH in Swift-XRT data by studying hyperluminous X-ray source candidates (HLX), which were identified through a cross-correlation of the Swift-XRT catalog with the Galaxy List for the Advanced Detector Era (GLADE) covering nearly 2 million galaxies with high completeness up to 300Mpc. This selection contains foreground stars and background AGN that we partly eliminate by developing a classification into 3 classes (AGN, star and stellar-mass compact objects) based on the source properties. Thanks to this classification we are able to obtain 110 HLX candidates including 5 HLX previously identified in the literature. We are currently validating the nature of these objects.

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Discovery of one super-Eddington neutron star in an eclipsing X-ray binary

Author(s): Song Wang

Co-author(s): Roberto Soria ; Ryan Urquhart ; Jifeng Liu

We discovered eclipses and dips in one luminous (and highly variable) X-ray source (CXOM51 J132946.1+471042) in M51. It has a two-component spectrum with additional thermal-plasma emission; it approached an X-ray luminosity of 10^{39} erg s−1 during outbursts in 2005 and 2012. From the timing of three eclipses in a series of Chandra observations, we determine the binary period (52.75 ± 0.63 h) and eclipse fraction (22 ± 0.1 per cent). We also identify a blue optical counterpart in archival Hubble Space Telescope images, consistent with a massive donor star (mass of ~20–35 M). By combining the X-ray light-curve parameters with the optical constraints on the donor star, we show that the mass ratio in the system must be M_2/M_1~ 18 and therefore the compact object is most likely a neutron star (exceeding its Eddington limit in outburst). The general significance of our result is that we illustrate one method (applicable to high-inclination sources) of identifying luminous neutron star X-ray binaries, in the absence of X-ray pulsations or phase-resolved optical spectroscopy. Finally, I will discuss the different X-ray spectral appearance expected from super- Eddington neutron stars and black holes at high viewing angles.

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NuSTAR Surveys of M31 and M33: Identifying Black Holes and Neutron Stars in the X-ray Binary Populations of our Nearest Neighbors

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X-ray binaries (XRBs) trace old and new stellar populations in galaxies, and thus star formation history and star formation rate. X-ray emission from XRBs may be responsible for significant amounts of heating of the early Intergalactic Medium (IGM) at Cosmic Dawn and may also play a significant role in reionization. Until recently, the hard emission from these populations could only be studied for XRBs in our own galaxy, where it is often difficult to measure accurate distances and thus luminosities. The launch of NuSTAR, the first focusing hard X-ray observatory, has allowed us to resolve the brightest XRBs (down to L_X ~few times 10^{38} erg/s) in galaxies like NGC 253, M83, and M82 up to 4 Mpc away. To reach much lower X-ray luminosities that are more typical of XRBs in the Milky Way ($L_X < 10^{37}$ erg/s), we have observed multiple fields in M31 and M33. In M31, 4 deep fields and 7 shallow fields, totaling roughly 2 Ms, have been executed, while M33 is covered by 3 moderate exposure fields totaling 600 ks. We detect 120 sources in the 4-25 keV band in M31 and over 40 hard band (12-25 keV) accreting black holes and neutron stars, distinguished by their spectral shape in this band. The luminosity function (LF) of the hard band detected sources are compared to INTEGRAL- and Swift/BAT-derived LFs of the Milky Way population, which reveals a possible excess of luminous sources in M31 when correcting for star formation rate and stellar mass. In M33, we find a potentially higher fraction of black hole accreting sources, perhaps related to its higher specific star formation rate. The populations in both galaxies are compared to the total XRB population thus far detected in all the galaxies observed by NuSTAR.

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Universal detection of high-temperature emission in X-ray isolated neutron stars

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X-ray Isolated Neutron Stars (XINSs) are nearby, strongly magnetized, thermally emitting neutron stars without non-thermal emission in any energy band, from radio to Gamma-ray. So far, only seven XINSs discovered by ROSAT are known. Since the discovery in 1990s, their X-ray spectra have been interpreted simply with a single-temperature blackbody (1BB) model.
Stacking all the data observed with XMM-Newton, we find that the brightest XINS, RX J1856.5-3754, shows high-temperature emission, "keV-excess", over the 1BB model (Yoneyama et al. 2017, PASJ 69, 51). We then search for the similar excess emission in the other six XINSs and find that all the six show the keV-excess (Yoneyama et al. 2019, PASJ 71 17). Their X-ray spectra including the keV-excess are universally reproduced with a two-temperature blackbody model. Five out of seven sources show similar spectral parameters with those of magnetars. For the other two sources, the emission mechanism of the keV-excess can be understood as emission from rotating polar caps. We discuss the similarity between the XINSs and magnetars and the possibility to determine the mass and radius of neutron stars using the keV-excess.

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Spectral and temporal properties of thermal Comptonization in X-rays

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Comptonization by thermal electrons at mildly relativistic temperatures appears to be one of the major radiative processes giving rise to the observed X-ray emission from accretion onto compact objects. This is evidenced by ubiquitous high-energy cutoffs in hard spectral states occuring at E>kT, which are usually well fitted by models of that process. Accurate determination of the electron temperature is important for proper understanding of the physical nature of the source, in particular for determination of the role of electron-positron pair production. Some of the existing codes, in particular 'nthcomp', underestimate kT already in the mildly relativistic regime. Here we develop a new and much more accurate public code, 'thcomp', based on a modification of the Kompaneets equation with an escape term. The accuracy of that code and of other available ones is tested using our new public Monte Carlo code, 'compton'. Using the latter, we also study timing properties of Comptonization, in particular the distribution of photon arrival times and the evolution of the average photon energy.

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Burst probe to XRB accretion and Insight-HXMT observation

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Although corona has been being well used in modelling accretion of XRBs, especially on aspects of the spectral state transitions and correlation with launching of a jet, so far its nature is still less known, especially on aspect of the formation mechanism. To probe this puzzle observationally, one has firstly to have a proper probe like the intense short soft X-ray shower, since the corona is in definition less emissive and can only be lighted up with the incident soft X-rays. This probe, however, falls short in BH XRBs, but fits well the thermal nuclear flashes occurring on the NS surface. We therefore took the type-I burst to probe the accompanied disk/corona evolution and obtained an atoll sample which shows that corona can be cooled off by the burst shower. Further studies suggest that, a variety of issues apart from corona can be addressed as well by taking this probe. The current shortage in observations at hard X-rays is the relatively poor statistics of the data, which can be diminished by the HXMT mission.

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AstroSat observation of GX 5-1: Spectral and timing evolution

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We report on the first analysis of AstroSat observation of the Z-source GX 5-1 on February 26-27, 2017. The hardness-intensity plot reveals that the source traced out the Horizontal and Normal branches. The 0.8-20 keV spectra from simultaneous SXT and LAXPC data at different locations of the hardness-intensity plot can be well described by a disk emission and a thermal Comptonized component. The ratio of the disk flux to the total i.e. the disk flux ratio increases monotonically along the horizontal to the Normal one. Thus, the difference between the Normal and Horizontal branches is that in the normal branch, the disk dominates the flux while in the horizontal one it is the Comptonized component which dominates. The disk flux scales with the inner disk temperature as $T^{5.5}$ and not as T^4, suggesting that either the inner radii changes dramatically or that the disk is irradiated by the thermal component changing its hardness factor. The power spectra reveal a Quasi Periodic Oscillation whose frequency changes from ~ 30 Hz to 50 Hz. The frequency is found to correlate well with the disk flux ratio. In the 3-20 keV LAXPC band the r.m.s of the QPO increases with energy (r.m.s $\propto E^{0.8}$), while the harder X-ray seems to lag the soft ones with a time-delay of a milliseconds. The results suggest that both the temporal and spectral properties of the source are determined by the geometry of the system which is characterized by the disk flux ratio and that the QPO has its origin in the corona producing the thermal Comptonized component.

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Accretion in Ultracompact X-ray Binaries: A Unified Picture of 4U 1626-67

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Co-author(s): Deepto Chakrabarty [1] ; Herman Marshall [1] ; Norbert S. Schulz [1]

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Ultracompact X-ray binaries (UCXBs) are binaries with a neutron star accretor and an orbital period less than 80 minutes. Here, I focus on our comprehensive review of *Chandra* observations of the unique UCXB 4U 1626-67, the only known UCXB to host a strongly-magnetized accreting pulsar. Our sophisticated modeling of the X-ray gratings spectra finds intriguing results: we observe strong, double-peaked emission lines of neon and oxygen, consistent with an accretion disk made up of a collisionally-ionized, two-temperature, pure Ne/O plasma. This is an unexpected result in several respects: the X-ray pulsar was expected to produce a photoionized plasma, not collisional; the two-temperature structure is difficult to reconcile with the measured distance scales of the accretion disk; and the composition of the donor is out of line with any standard white dwarf model. However, we believe we have come up with a coherent picture of this source that reconciles most of these conflicts, which I will present.

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The First Hard X-Ray Survey of the Central 30 Parsec of the Galactic Center Searching for Faint High Mass X-Ray Binaries

Author(s): Yi Won Kim ; Jung Kyu Jang ; Eric Wang

This investigation reports the finding of three potential High Mass X-ray Binary (HMXB) candidates using Nuclear Spectroscopic Telescope Array (NuSTAR) in the central 30 parsec of the Galactic Center (GC) near the supermassive black hole Sagittarius A*. With the follow-up data of the GC by NuSTAR which observed 70 new hard X-ray sources, we aimed to search for faint HMXBs. To determine high-mass infrared counterparts of M~10 M⊙, we utilized the Spitzer IRAC GC survey and conducted source registration on Chandra observations to minimize the absolute astrometric errors, which are unique for each observation. Various characteristics of these HMXB candidates including stellar types, pulsations, and luminosities were analyzed by spectral and timing analysis. This was followed by a stellar density calculation to further verify that the high-mass infrared counterparts are associated with each of its HMXB candidates. This investigation shows the likelihood of the existence of other faint HMXBs in the GC that are undiscovered due to lack of sensitivity of previous telescopes.

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Observation of the supernova remnant RX J1713.7-3946 in hard X-rays with INTEGRAL

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During Galactic Center survey program by IBIS telescope on-board INTEGRAL the supernova remnant RX J1713.7-3046 was observed in hard X-ray band (17-60 keV) for the first time. The surface brightness maps of the supernova remnant in 17-27-36-50-120 and 17-60 keV energy bands will presented in this talk. The spectra of two brightest clumps of RX J1713.7-3946 are characterized by a power law spectrum with photon index ~3. The surface brightness map of RX J1713.7-3946 in soft X-ray band (1-10 keV), based on the XMM-Newton observations (2001-2017), demonstrates good agreement with that obtained by IBIS telescope, which points out to a single mechanism working in soft and hard X-rays. The XMM-Newton spectrum of RX J1713.7-3046 in the 0.8-10 keV band is well described by the power-law model with photon index ~2, which indicates a change of the spectral slope somewhere between 10 and 17 keV. The value of the slope change (or high-energy cutoff) contains important information about the acceleration efficiency of cosmic ray particles in the supernova remnant.

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Using Fourier Resolved Spectroscopy to probe the X-ray variabilitty of the BHC Swift J1753.5-0127

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Swift J1753.5-0127 (J1753 hereafer) is a Low Mass X-ray Binariy (LMXB) hosting a Black Hole of ~3 solar masses (BHC), with a very short orbital period of around 3 hrs. The source exhibited an unusually long outburst cycle which lasted for approximately 12 years between 2005 and 2017 before returning to quiescence. We have obtained and analyzed multi-epoch series of archival data from XMM-Newton, NuStar, the Neils Gherels Observatory (previously known as Swift) to search for temporal and spectral variability along different phases of the long outburst. The outcome of the analysis reveals a rich spectra variability behavior. In addition, thanks to the brightness of the X-ray source, we have been able to perform Fourier Resolved Spectroscopy (FRS). The FRS spectra indicate the presence of a weak (though prominent) broad and variable Fe-like feature, around 6.4 keV, in the spectra of J1753. Interpretations of the spectral changes assuming a variable accretion flow to the BH and the weak presence of the iron line are discussed.

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Multi-Epoch X-ray observations of globular cluster M62

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The globular clusters (GCs) are dense stellar systems which can produce the compact binaries (e.g. cataclysmic variables (CVs), millisecond pulsars (MSPs), quiescent low-mass X-ray binary (qLMXBs)) through frequent dynamical interactions. M62 is among the GCs with the highest stellar encounter rate. In our analysis, we identify 43 X-ray sources within M62' s half-light radius from two different observations with Chandra (0.3 – 7.0 keV) separated by ~12 years. Based on the distribution in the X- ray color-luminosity diagram and the variability analysis, 9 CV candidates and 4 qLMXBs candidates have been suggested. 2 MSP counterparts and 1 black hole (BH) candidate have been identified by the positional coincidence with the radio position. For all these compact binaries, we have also examined their spectral properties in details.

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Merging in the Coma Cluster - Slingshot Tails and Runaway Shocks

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We describe the merger of the NGC 4839 group with the Coma cluster using X-ray observations from the XMM-Newton and Chandra Obsservatories (Lyskova et al. 2019). X-ray data show two prominent features: (i) a long (600 kpc in projection), bent tail of cool gas trailing (towards the south-west) the optical center of NGC 4839, and ii) a 'sheath' region of enhanced X-ray surface brightness enveloping the group, which is due to hotter gas. We argue that a post-merger scenario provides a consistent explanation of the observed features. In this scenario a slingshot tail (Sheardown et al. 2019) is formed when the group, initially moving to the south-west, reverses its radial velocity after crossing the apocenter.bThe ram pressure ceases and the ram-pressure-displaced gas falls toward the center of the group (to the south west, away from the Coma cluster center) and overshoots the group center. Shortly after apocenter passage, the optical galaxy, dark matter and gaseous core are moving to the north-east, while the displaced gas continues moving to the south-west. In this scenario, the shock, driven by the group before reaching apocenter, has detached from the group and would be located close to the famous relic to the south-west of the Coma cluster. Such "runaway" shocks can survive in cluster outskirts where the density profile is sufficiently steep (Zhang et al. 2019).

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Multi-phase interplay in the jellyfish galaxy JW100

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JW100 is a massive spiral galaxy infalling in the galaxy cluster Abell 2626. The extreme intra-cluster medium pressure is currently stripping the galaxy of its cold gas, producing the peculiar filaments typical of a jellyfish galaxy, where star formation is taking place. Interestingly, MUSE and Chandra observations revealed two odd characteristics of this galaxy. On the one hand, MUSE revealed an elongated, ionized tail of cold gas whose spectral properties can not be explained by star-formation only. On the other hand, Chandra detected a striking, diffuse X-ray emission that follows remarkably the stripped tail.
We performed an accurate study of the spectral properties of the X-ray emitting plasma, its correlation with cold galactic filaments and the interaction of the galaxy with the surrounding ICM. The emergent picture is that the interplay of cold ISM and hot ICM originated the X-ray emitting plasma that, in turn, may have played a role in the origin of the extended ionized structure. Therefore, JW100 represents an excellent laboratory to study the interaction between the different gas phases and its implications for star formation.

HOT AND DIFFUSE BARYONS / 303

An XMM-Newton study of the hot gas in Early type galaxies

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The distribution of hot ISM in early type galaxies (ETGs) bear the imprint of its formation and evolutionary history. The high sensitivity and large field of view of XMM-Newton has made it possible to investigate this diffuse emission in the galaxy outskirts, which is critical in understanding the interaction of this hot gas with the surrounding medium (e.g., by ram pressure stripping) and neighbouring galaxies (e.g., sloshing, merging), by measuring its spectral properties and mass profile on a larger scale.
I will be presenting an overview of the X-ray Galaxy Atlas project, where we systematically analysed the archival XMM-Newton observations of 50 ETGs and produced spatially resolved 2D spectral maps (temperature, density, pressure, entropy, abundances), with the aim of studying the distribution of the hot gas in these ETGs. These 2D spectral maps are more useful in revealing unique features in the distribution of hot gas, which may be not visible in 1D radial profiles or 2D surface brightness maps.
These results will be used complementary with the existing products from the Chandra Galaxy Atlas (http://cxc.cfa.harvard.edu/GalaxyAtlas/v1/), to investigate both small scale and large scale structures in the distribution of the hot gas in ETGs.

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X-rays, SZ and Optical joint analysis of the hot and diffuse baryons within the Planck-detected triple-cluster systems

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Recent stacking analysis of Sunyaev-Zel'dovich (SZ) oberservations of hundreds of superclusters have revealed the presence of the warm-hot intergalactic medium (WHIM) as a component of the intercluster gas. This indicates that superclusters are good targets to directly study the WHIM.
We are conducting a detailed study of two triple-cluster systems detected by Planck. We will jointly analyse the SZ data from Planck together with X-rays and galaxy distribution observations with *XMM-Newton* and *VTL/FORS2* respectively. We will present the supercluster components including a possible direct detection of WHIM. We will discuss their physical properties (e.g. temperature, density, pressure, entropy) and their impact on the missing baryon problem.

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Dissecting the chemical properties of the ICM in massive galaxy clusters

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We investigate the spatial distribution of iron in the intracluster medium (ICM) of massive clusters at different cosmic epoch, focusing on two distinct components: a central peaked distribution, and a wider, flatter component. Thanks to the angular resolution of Chandra data, we are able to follow the increase in the size of the central component, which, however, does not grow significantly in mass in the range 0>1, and a slow diffusion process possibly driven by the mechanical-mode feedback from the central galaxy. On the other hand, the flatter and wider component includes the majority of the metal mass and has a much slower evolution with epoch. We recast the evolution of iron in terms of total iron mass within a given radius in each component, and attempt to constrain the enrichment mechanisms and the associated time scales. As a byproduct of the high spatial resolution analysis of iron distribution, we are also able to investigate the origin of the "central iron drop", a small-scale decrement observed at the center of the iron peak in some clusters. We find that although the iron drop is mostly due to a mechanical process removing the highly enriched ICM from the center, it should also be ascribed partially to iron depletion onto dust grains, consistent with the most recent scenario of the baryon cycle in cool-core clusters.

HOT AND DIFFUSE BARYONS / 306

Can we quantify the hydrostatic bias using 2D temperature maps?

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The ICM often shows significant two-dimensional structure generated by mergers and/or AGN feedback. Thermodynamical 2D maps have been extensively used in the study of galaxy clusters thanks to their great potential to characterize the dynamical state of a system. However, to date they are only used for a qualitative analysis (e.g. the determination of a shock or a cold front) leaving their full potential unexploited. We will discuss how temperature maps can be used, not only to identify substructures or study asymmetries in the projected distribution, but also to investigate the possible biases in the determination of cluster properties, such as global gas temperature or total mass and the impact on the scaling relations.
We will present a first attempt to use the scatter of the 2D maps to probe possible biases in hydrostatic mass estimates as a function of cluster dynamical state.

HOT AND DIFFUSE BARYONS / 307

Chemical enrichment in galaxy clusters, groups, and elliptical galaxies hot atmospheres

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Whereas the extreme conditions of the first minutes after the Big Bang produced nearly all the hydrogen and helium in the Universe, the most common heavier elements - or metals - are synthesized in the core of stars and in supernova explosions. On the other hand, the very hot and diffuse intracluster medium (ICM), glowing in X-ray and detected in the large gravitational potential well of galaxy clusters and groups, is also rich in metals. This means that the building blocks of life, synthesized by billions of supernovae over cosmic ages, are present even at the largest scales of the Universe, as they continuously enrich the ICM.
In this talk, we will see how the abundance measurements of key-elements in the hot atmospheres of galaxy clusters, groups, and ellipticals observed with the current X-ray observatories helps to understand how and which epoch of the cosmic history the ICM got enriched.
Finally, I will discuss how future X-ray observatories will push forward our understanding of the ICM enrichment.

HOT AND DIFFUSE BARYONS / 308

Chandra observations of the AS0295 cluster

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Mergers between clusters of galaxies are highly energetic events capable of drastically changing the observed properties of clusters. Therefore, merging events provide a unique set-up for the study of cluster physics and the behavior of the interaction between gas, stars and dark matter.
We present the results of the X-ray analysis of the AS0295 cluster, a low redshift (z=0.3), massive cluster caught in the process of merging. Chandra X-ray images show a disturbed morphology, with X-ray emission elongated in the SE-NW direction. While the secondary cluster has a clearly visible X-ray peak and cool gas (~6 keV) associated with it, the primary has a flatter surface brightness distribution and a high temperature (~9.5 keV), similar to the mean temperature of AS0295.
We detected several merging signatures, such as a cold front close to the secondary's core, a plume of cool gas emerging from primary cluster and two possible shocks: one in the vicinity of primary and the other leading the secondary.
Comparing the X-ray information with literature results of binary merger simulations, we discuss the dynamical state of AS0295. Moreover, published optical and radio studies of this cluster show the presence of an offset between gas and dark matter in the primary cluster and radio emission associated with this system. Having all this complementary information about AS0295 cluster, we show that this system represents a promising candidate for the understanding of the process of cluster merging and the nature of dark matter.

HOT AND DIFFUSE BARYONS / 309

A BCG with offset cooling: is the AGN feeding cycle broken in A2495?

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We present a combined radio/X-ray analysis of the poorly studied galaxy cluster Abell 2495 (z=0.07923) based on new EVLA and Chandra data. We also analyze and discuss Hα emission and optical continuum data retrieved from the literature. We find an offset of ~ 6 kpc between the cluster BCG (MCG+02-58-021) and the peak of the X-ray emission, suggesting that the cooling process is not taking place on the central galaxy nucleus. We propose that sloshing of the ICM could be responsible for this separation. Furthermore, we detect a second, ~ 4 kpc offset between the peak of the Hα emission and that of the X-ray emission. Optical images highlight the presence of a dust filament extending up to ~ 6 kpc in the cluster BCG, and allow us to estimate a dust mass within the central 7 kpc of $1.7 \cdot 10^5$ Msun. Exploiting the dust to gas ratio and the $L_{H\alpha}$-M_{mol} relation, we argue that a significant amount (up to 10^9 Msun) of molecular gas should be present in the BCG of this cluster. We also investigate the presence of ICM depressions, finding two putative systems of cavities; the inner pair is characterized by $t_{age} \sim 18$ Myr and $P_{cav} \sim 1.2 \cdot 10$^43 erg s^{-1}, the outer one by $t_{age} \sim 53$ Myr and $P_{cav} \sim 5.6 \cdot 10^{42}$ erg s^{-1}. Their age difference appears to be consistent with the free-fall time of the central cooling gas and with the offset timescale estimated with the Hα kinematic data, suggesting that sloshing is likely playing a key role in this environment. Furthermore, the cavities' power analysis shows that the AGN energy injection is able to sustain the feedback cycle, despite cooling being offset from the BCG nucleus.

HOT AND DIFFUSE BARYONS / 310

X-ray properties of clusters in the C-EAGLE simulations

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Cluster outskirts are an area of great interest as they contain a wealth of information as to how the hot intracluster medium (ICM) forms and contributes to the growth of large scale structures. With the advent of *Athena*, measurements of the ICM should be possible beyond the virial radius. To this end, we present the metallicity profiles and distribution of different metals for the C-EAGLE simulation, a suite of 30 massive galaxy clusters (M500 > 10^{14} Msun), focussing on the cluster outskirts, r > R200.
We also present the CELR (C-EAGLE at low resolution) sample, for which we have investigated how using mock X-ray temperatures combined with mock X-ray density profiles leads to more biased estimates for the mass of more massive clusters. We have found that this bias can be improved by including a model for non-thermal pressure, but a mass dependence of the bias is still seen.

HOT AND DIFFUSE BARYONS / 311

X-ray and SZ scaling relations from galaxies to clusters with the IllustrisTNG simulations

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The observable thermodynamical properties of the intracluster medium reflect the complex interplay between astrophysical processes such as AGN feedback and the gravitational collapse of the host halo. Using the IllustrisTNG simulations, we measure the X-ray emission and the impact of the gas on CMB through the Sunyaev-Zel'dovich effect over a wide range of mass scales: from galaxies and groups, all the way to the most massive clusters ($M_{500crit} > 10^{15} M_{sun}$). We calculate the X-ray properties of our simulated haloes using methods that are consistent with observational techniques, which account for the bias and scatter introduced by estimating halo masses. Thus, we infer the scaling relations between X-ray measurements such as the soft-band luminosity and the spectroscopic temperature, hot gas content and Sunyaev-Zel'dovich properties, and we find reasonable agreement between IllustrisTNG and the observed relations. Our work helps to better understand the role played by AGN feedback from cluster to galaxy scales, informing future subgrid BH feedback models. Moreover, our results highlight the scatter and bias introduced by estimated masses, and thus the importance of converting simulated ICM properties to the observable space when comparing simulations to current X-ray observations. Finally, we will provide important predictions for future X-ray missions such as eROSITA, Athena and Lynx regarding the redshift evolution of the X-ray and SZ scaling relations.

HOT AND DIFFUSE BARYONS / 312

What is the metal content of the Intra-Cluster Medium?

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Co-author(s): Sabrina De Grandi [1] ; Silvano Molendi ; Fabio Gastaldello ; Mariachiara Rossetti ; Dominique Eckert

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We make use of the XCOP sample to address two fundamental and unanswered questions: 1) What is the metal content of the Intra-Cluster Medium? 2) Is the metal content of the ICM consistent with that expected from the stellar population? We do this with XCOP, a very large program (VLP) on XMM-Newton designed to characterize a sample of 12 Massive Clusters out to large radii.

ACTIVE GALACTIC NUCLEI

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A Catalogue of XMM-Newton BL Lacs

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A XMM-*Newton* catalogue of BL Lac X-ray properties is presented based on the cross-correlation with the 1374 BL Lacs listed in the 13th edition of the Véron-Cetty and Véron (2010) catalogue.
X-ray counterparts to these objects are searched in the field of view of around 10000 XMM-*Newton* pointed observations. The cross-correlation yielded a total of 352 XMM-*Newton* observations which corresponds to 102 different sources. Data from the three EPIC cameras and OM were homogeneously analysed using the XMM-*Newton* SAS software. Images, lightcurves and spectral products are produced for those BL Lacs detected in any of the three EPIC cameras. Two different phenomenological models, with different variations of the absorbing column density, are tested: Log-Parabolic and Powerlaw. We determine the best fit model and extract its parameters, The results of the analysis are presented as a catalogue of X-ray spectral properties of the sample in the 0.2 - 10 keV energy band as well as in the V/UV band. Multiwavelength information at radio and gamma-ray energies complete the catalogue.

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Resolving the AGN Torus Spectrally, Spatially, and Temporally

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The NuSTAR and Swift survey of more than 150 obscured AGN in the local universe recently enabled basic parameters of the obscuring torus, such as the covering factor and the globally averaged column density, to be observationally constrained from the X-ray band. However, detailed analyses of particular AGN reveal that structural parameters of the torus may depend on the choice of the fitting model and its nuisance parameters, variability in intrinsic luminosity or line-of-sight column density, and contamination from non-nuclear emission. In modeling spatially unresolved single-epoch AGN spectra, these effects can be sources of systematic uncertainties that exceed statistical uncertainties on these important structural parameters. In this presentation I will demonstrate how X-ray spectroscopy (either broadband of with high spectral resolution) can be self-consistently combined with spatially resolved and multi-epoch data in order to help us in understanding the complexity of the AGN structure known under the deceptively simple name of the torus.

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X-raying winds in distant QSOs: the case of the Einstein Cross

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The characterization of AGN feedback is still an open issue. Theories and simulations indicate that AGN-galaxy co-evolution and feedback processes could be established through the generation of gas outflows. These are seen to arise from the innermost regions as powerful winds at sub-pc scales, visible in the X-ray band. We present the results from a systematic analysis of all the available *Chandra* and XMM-*Newton* data (as of October 2018) for Q2237+030, the Einstein Cross, a radio-quiet quasar at z_Q = 1.695, quadruply-imaged by a spiral galaxy at z_L = 0.0395.
We detect, for the first time, a fast X-ray wind in this object outflowing at v_{out}~ 0 1c, which seems to be powerful enough to significantly affect the host galaxy evolution ($Ė_{kin}$ ~ 9% L_{bol}). Given the absorption features detected throughout the data, we report also on the possible presence of a faster component of the wind (v_{out} ~0.5c). Evidence for outflows is found in nine spectra out of the sixteen analyzed, which allows us to give a rough estimate of the wind duty cycle as ~50%.

ACTIVE GALACTIC NUCLEI / 404

Exploiting the Chandra Source Catalog 2.0: the first science results

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The Chandra Source Catalog 2.0 is a powerful tool providing properties for 315,000 X-ray sources detected in the observations taken prior of 2015. We cross-matched the Sloan Digital Sky Survey DR14 and the CSC2.0 to build a sample of >6500 optically selected quasars that have both optical and X-ray spectroscopic information. This sample can be considered as a gold mine for studies on the quasar population. As a first application, we used it to analyze the relation between the X-ray and Ultraviolet luminosities in quasars and its non-evolution with redshift. Recently, it was found that the dispersion of this relation is not intrinsic, but mostly due to observational issues in measuring the two fluxes (at 2kev and 2500Å rest-frame). The results published so far with archival samples made use of only photometric data, reaching a dispersion of 0.24 dex on the relation. Here we present a huge step forward by using spectra provided by the newly released catalog, which allow us to obtain an unprecedentedly small dispersion of sigma<0.20 dex.

ACTIVE GALACTIC NUCLEI / 405

Supermassive Black Hole Winds in X-rays (SUBWAYS)

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We have been awarded a Large Program of ~1.6 Ms with XMM-Newton in AO18, SUBWAYS ("Supermassive Black Hole Winds in X-rays"), designed to provide a unique observational framework to test the validity of physical models for Active Galactic Nuclei (AGN) outflows, and to ultimately understand their impact into their host galaxies. SUBWAYS will observe a representative sample of 19 objects at z=0.1-0.5, above the knee of the AGN luminosity function with the main goal of obtaining a statistically sound estimate of the duty cycle and physical parameters of ultra-fast outflows (UFOs). In the poster we we will highlight the main objectives of our program, we will present the sample selection and properties, and we will show the first results from the XMM-Newton observations available by the time of the conference.

ACTIVE GALACTIC NUCLEI / 406

X-ray reverberation in AGN: towards an extended corona

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X-ray reverberation in Active Galactic Nuclei, believed to be the result of the reprocessing of coronal photons by the underlying accretion disc, has allowed us to probe the properties of the inner-most regions of the accretion flow and the central black hole. Our current model (KYNREFREV) computes the time-dependent reflection spectra of the disc as a response to a flash of primary power-law radiation from a point source corona located on the axis of the black hole accretion disc (lamp-post geometry). Full relativistic effects are taken into account. The ionization of the disc is set for each radius according to the amount of the incident primary flux and the density of the accretion disc. We detect wavy residuals around the best-fit reverberation model time lags at high frequencies. This result suggests that the simple lamp-post geometry does not fully explain the X-ray source/disc configuration in Active Galactic Nuclei. There has been a noticeable progress into the development of codes for extended coronae (Wilkins+16, Chainakun & Young 2017, Taylor & Reynolds 2018a,b). Indeed, the model from Chainakun & Young (2017), consisting of two axial point sources illuminating an accretion disc that produce the reverberation lags is able to reproduce the observed time-lag versus frequency spectra.

ACTIVE GALACTIC NUCLEI / 407

Uncovering luminous and highly obscured AGN with mid-infrared surveys

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Extensive efforts have been devoted during the past decade to uncover the AGN hidden under the most extreme X-ray column densities, the so called Compton-thick AGN. Still, although Compton-thick AGN could represent a significant fraction of the entire AGN population, they have escaped detection. Mid-IR surveys with the all-sky Wide-field Infrared Survey Explorer could uncover, at least in part, the elusive highly obscured SMBH growth in the most extreme luminous AGN. Although a few studies have already presented results from followup campaigns of WISE-based AGN samples, they typically lack the X-ray depth necessary to reveal the true nature of many of the objects.
In this talk I will present the results of a detailed analysis of the X-ray properties of a complete, mid-IR 12 microns flux-limited sample, of 97 luminous AGN candidates selected with WISE. The full 6 deg2 survey area has very deep X-ray coverage from XMM-Newton observations, reaching X-ray fluxes of just 10^-15 erg/cm2/s. To date 92 objects have spectroscopic redshifts and optical classifications. Thus, we can evaluate the reliability and effectiveness of WISE to uncover luminous, highly obscured systems. Moreover, we can provide independent estimates of the space density of obscured accretion up to redshift one, which can be compared with the results derived from wide-area, and shallower, X-ray surveys. We also discuss the prospects of detecting With Athena the 24% of the sample yet undetected with XMM-Newton.

ACTIVE GALACTIC NUCLEI / 408

The properties of extragalactic sources in the Chandra Source Catalog 2.0

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The Chandra Source Catalog release 2.0 (CSC 2.0) includes all the observations prior to end of 2014, performing detection and extracting source properties, and making them available in an easily accessible format ready for scientific discoveries. The CSC 2.0 covers ~600 deg2 of the sky, sampling widely different astrophysical environments, allowing both galactic and extragalactic studies with large samples of sources. The ~315,000 unique X-ray sources in CSC 2.0 allow scientists to perform statistical studies by making use of the extensive set of uniformly calibrated properties (more than 100/source) in multiple energy bands and across a broad range of source fluxes (5x10^-17 to 10^-12 in the 0.5-2 keV band). Moreover, a large variety of data products are available both at the source level (e.g., spectra, light curves, and more) and at the field level where the source is detected (e.g., merged

events files, exposure and background maps). In this talk, I will give a brief overview of the catalog and I will focus on the combination of X-ray and multiwavelength properties for the extragalactic sources, allowing us to to unlock the extreme power of this archive. I will present the source classification based on X-ray plus multi-wavelength data or X-ray only (making use of machine learning methods). I will also showcase the results of the XZ method applied to this dataset to extract redshift information from X-ray spectra of obscured sources.

ACTIVE GALACTIC NUCLEI / 409

The intrinsic fraction of type 2 AGN

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Most AGN studies find that the obscured AGN fraction decreases as the luminosity increases. This is usually explained by invoking receding torus models. However, recent results for the intrinsic type 2 fraction based on a complete hard X-ray selected sample (BUXS: Bright Ultrahard XMM-Newton Survey) showed little to no luminosity dependence, and uncovered a population of hidden luminous Compton-thick AGN. We furthered this analysis by applying a fully Bayesian approach to derive the distribution of column densities (N_H) for the 252 AGN with spectroscopic redshifts within BUXS. For a sub-sample of type 1 AGN at z = 0.05-1, we compared these results to the ones obtained for the optical obscuration. We fitted the optical spectra to classify the sources in types (1.0-1.9), based on emission line ratios, and to measure the optical-UV continuum obscuration (A_V). We find that there is a clear tendency towards increasing A_V and N_H from 1.0 to 1.9 objects, with a statistically significant difference between the 1.0-1.2-1.5 and 1.8-1.9 subsets, showing that they are different families. Regarding the dust-to-gas ratio (A_V vs. N_H) we do not find a clear tendency, instead the distribution shows a large scatter. We have also explored the suitability of the ratio of the broad Hα and Hβ emission lines to estimate the obscuration in type 1 AGN, finding average values similar to previous ones but with substantial dispersion, concluding that this ratio should be taken with extreme caution, if not discarded as an obscuration measurement altogether.

ACTIVE GALACTIC NUCLEI / 410

Studying the geometry and dynamics of the inner motion flows in AGN via FeK line variability

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The dynamics and geometry of the innermost regions of accretion flows in Active Galactic Nuclei (AGN) are still largely uncertain. A fundamental way to understand these phenomena is the study of X-ray variability properties of the Fe K line complex since it is assumed to be a probe of the geometry of the matter flows close to SMBH and also of their physical state (i.e. ionization, density, velocity).
In my work I have analyzed XMM-Newton/pn spectra of bright X-ray nearby Seyfert 1 galaxies, adopting the analysis technique of the residual mapping: long exposures are sliced in time and each spectrum is fitted with simple models accounting only for the continuum emission; the residuals are

then used to build-up an image in the time vs. energy domain to maximize possible spectral features and if/how they evolve in time, coupling time and spectral analysis.
My study is focused on the search for a modulated signal of emission and absorption features: it presence, or the lack of it, would allow us to understand the geometry of the structure of the absorbers/emitters in the central regions of the AGN. Also, comparison of different modulation patterns could show some kind of correlation between different phenomena, pointing to an interconnection between the motions of emitting and absorbing material.

ACTIVE GALACTIC NUCLEI / 411

The jet-disc connection in gamma-ray-emitting narrow-line Seyfert 1 galaxies: the X-ray view

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Before the launch of the Fermi satellite only two classes of AGN were known to generate relativistic jets and thus to emit up to the gamma-ray energy range: blazars and radio galaxies, both hosted in giant elliptical galaxies. The discovery by the Large Area Telescope on-board the Fermi satellite of variable gamma-ray emission from a few radio-loud narrow-line Seyfert 1 galaxies (NLSy1) revealed the presence of an emerging third class of AGN with relativistic jets. NLSy1 are usually hosted in late-type galaxies with relatively small black hole masses. This finding opened new challenging questions about the nature of these objects, the jet-disc connection, the emission mechanisms at high energies, and the formation of relativistic jets.
High quality spectra obtained by XMM-Newton are fundamental to determine if the X-ray spectrum of these sources is completely dominated by the jet emission or there is some contribution from the accretion flow, such as the soft X-ray excess and the Fe K line. NuSTAR observations provide a complementary coverage in the hard X-ray part of their spectrum.
In addition, thanks to the analysis of Swift and XMM-Newton data collected between 2008 August and 2019 March, we investigate the spectral and flux variability of gamma-ray-emitting NLSy1 on different time-scales and the connection with the gamma-ray emission observed by Fermi-LAT and the optical and UV emission observed by Swift-UVOT and XMM-OM. Moreover, the circum-nuclear environment of these NLSy1 could potentially provide a wealth of information on the radiative and mechanical feedback. Both feedback modes can be investigated through emission and absorption features arising in the X-ray spectrum. The high-resolution spectroscopic capability of XMM-Newton will be further exploited searching for such features in the spectra of gamma-ray-emitting NLSy1.
In this talk we discuss the results of the analysis of XMM-Newton, NuSTAR, and Swift data available for the nine gamma-ray-emitting NLSy1 detected by Fermi-LAT so far and we study the relation between accretion flow and jet, and the emission mechanisms at work in these NLSy1. Finally, the X-ray properties of the gamma-ray-emitting NLSy1 will be compared to what was observed in gamma-ray-emitting radio galaxies and blazars.

ACTIVE GALACTIC NUCLEI / 412

The AGN activity in merging galaxies observed in optical and X-ray waveband

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We will present results from the MAGNA (Multiple AGN Activity) project focused on the detection and study of multiple supermassive black hole systems.
With the main goal of understanding the mechanisms that trigger the AGN in different stages of galaxy mergers, we compare the physical properties of merging galaxies hosting at least one AGN with isolated systems. Optical (SDSS) and X-ray (XMM and Chandra) data sets allowed us to detect and characterize an optically selected sample of merging systems at 20–100 kpc separation, by measuring the accretion rate, the nuclear absorption and (when possible) the BH mass. The talk will reflect on broader implications of these findings when considering the current hydrodynamical and cosmological simulations of merging BH.

ACTIVE GALACTIC NUCLEI / 413

AGN Fe-K reverberation lags explained by the outflow

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Fe-K reverberation lags are commonly observed in Seyfert galaxies.
If the observed short lag timescale (~100 sec) is literally interpreted as the light-travel time, an extremely compact X-ray emitting corona is hinted to locate at very close to the black hole.
Alternatively, the apparently short Fe-K lag may be a natural consequence of the much further reprocessing site where the light-travel time is ~1000 sec, such that the Fe-K photon lags are "diluted" by the direct photons which are not lagged and ~10 times more dominant in number in the Fe-K energy band. We carried out a precise Monte-Carlo simulation of the Fe-K reverberation lags expected from AGN outflow. We assumed a realistic biconical geometry of the outflow which is highly photo-ionized. As a result, we have succeeded to quantitatively explain the short Fe-K reverberation lags observed from 1H0707-405 and Ark 564. While these sources show very similar Fe-K lag features, the Fe-K spectral features are very different; 1H0707-405

shows a strong P-Cygni profile while Ark 564 shows a much weaker spectral signature. These spectral differences are understood in the context of the outflow model, assuming a large outflow solid-angle in the line-of-sight in the former case, and a smaller outflow solid-angle out of the line-of-sight in the latter case. The hot-inner outflow will eventually get fragmented into clumpy clouds due to instability. Such outer clumpy clouds cause partial covering of the central X-ray emitting region, and change of the partial covering fraction is responsible for observed spectral variations. Consequently, the "Hot-inner and Clumpy-outer Wind" model simultaneously explains both the Fe-K reverberation lags and spectral variations of Seyfert galaxies in 0.2-78 keV observed by XMM-NuSTAR, in terms of only changes of the partial covering fractions and intrinsic luminosities.

ACTIVE GALACTIC NUCLEI / 414

Study of high redshift X-ray sources through an analysis of the deepest X-ray field observed by XMM-Newton

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This work presents preliminary results of the survey carried out on one of the deepest X-ray field observed by the XMM Newton satellite. The survey is made by 13 observations taken over 2 years with a total exposure time of 1.6 Ms over a field of 30 × 30 arcmin^2 around the blazar 1ES 1553+113, which were originally addressed to the study of the Warm Hot Intergalactic Medium (Nicastro et al. 2018). We detect 472 X-ray sources with high likelihood (> 6). Preliminary properties (e.g. positions, fluxes at different bands, hardness ratios) are obtained. The X-ray source list was cross correlated with the source list obtained by the observation of the Gran Telescopio Canarias (GTC) over the same field in g,r,i, z bands. Thanks to the availability of photometric redshift, we obtain a sublist of AGNs candidates and their X-ray luminosities, their large scale distribution and the luminosity function as an indicator of the evolution of Supermassive Black Holes at high redshift. Perspective for the study of the X-ray Background (XRB) and Hard X-ray emitting Active Galactic Nuclei and of high redshift Quasars will be included

ACTIVE GALACTIC NUCLEI / 415

Physical parameters of the torus from mid-IR and X-ray simultaneous spectral fitting

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To understand the diversity of classes observed in active galactic nuclei (AGN) it is required to obscure the inner parts of a geometrically and optically thick torus of gas and dust from some lines of sight. However, this torus is not spatially resolved even for the closest AGN. Spectroscopic studies have been broadly used to characterize the main properties of the torus. However, the torus has a large number of parameters that have not been constrained yet. X-rays shows signs of the torus emission throughout the reflection component peaking at ~20 keV. The X-ray spectral shape depends on the geometry of this emission. Mid-infrared emission is another powerful tool to study the properties of the torus, due to the fact that continuum emission in this range is dominated by the heating of dust by the AGN. We explore the combination of X-ray and mid-infrared spectra to constrain the physical parameters of the torus because both show important signatures of obscuration.

To meet our goal we used the nearby type-2 IC 5063 as a test object. We included the high spectral resolution IRS/Spitzer spectra for mid-infrared observations and NuSTAR observations for X-rays. We used the radiative transfer code Borus (Baloković et al. 2018) for X-ray spectra and three models (Smooth from Fritz et al. (2006), Clumpy from Nenkova et al. (2008), and CAT3D-wind from Hoenig et al. (2017)) for mid-infrared spectra. The Borus model can be fitted with the X-ray spectral fitting software XSPEC. We develop a code able to convert mid-IR models and IRS/Spitzer spectra into XSPEC format to simultaneously fit mid-infrared and X-ray data. We found that the combination of the borus02 and Smooth models is the best choice to fit the mid-IR and Xspec spectra of IC 5063. Indeed both the inclination angle and the angular width of the torus can be linked indicating that the same structure that produces the reflection component is emitting through dust heating at mid-infrared. This is the first time such behavior is confirmed. Moreover, we found that all dusty torus parameters are found when the inclination and half-opening angles are linked between both baseline models. Therefore, we concluded that this technique can be used to infer the physical properties of the torus.

ACTIVE GALACTIC NUCLEI / 416

Looking near the AGN with Chandra

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We will present recent high resolution Chandra work on the inner few arc seconds regions of AGNs, including our recent work on ESO 428-G014 and NGC2110. Together with ALMA and optical data these results give us a new view of the multi-phase ISM, excited by the AGN

ACTIVE GALACTIC NUCLEI / 417

Accurate Solution of the Comptonization in X-ray Reflection Models

Author(s): Javier García[1]

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A large fraction of accreting black hole systems present clear evidence of the reprocessing of X-rays in the atmosphere of the accretion disk. The copious X-rays produced in the vicinity of a black hole illuminate the disk and produce a reflection spectrum which main hallmarks include fluorescent emission K-shell lines from iron (~6.4-6.9 keV), and a broad featureless component known as the "Compton hump" (~20-40 keV). The latter is produced by the scattering of high energy photons by the relatively colder electrons in the accretion disk, in combination with photo-electric absorption from iron. Until now, the treatment of this process in models of ionized X-ray reflection has been done in a very approximate manner using a Gaussian redistribution kernel. This approximation works sufficiently well up to ~100 keV, but it becomes largely inaccurate at higher energies and at relativistic temperatures. Here we report new calculations of X-ray reflection using a modified version of our model XILLVER, which now includes an accurate solution Compton scattering of the reflected photons in the disk atmosphere. This solution takes into account quantum electrodynamic and relativistic effects allowing the correct treatment of high photon energies and electron temperatures. We present new reflection spectra computed with this model, and discuss the improvements achieved in reproducing the correct shape of the Compton hump, as well as the effects of this new solution at softer energies.

ACTIVE GALACTIC NUCLEI / 418

Self-regulation between multiphase AGN outflows and hot halo rain

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Feeding and feedback tied to SMBHs play central role in the cosmic evolution of galaxies. The self-regulated AGN cycle is matter of intense debate. I review key numerical and observational results of how SMBHs are coupled to the multiphase gaseous halos, linking the inner gravitational radius to the galactic scale, and vice versa. The turbulent galactic halo radiatively cools through a multiphase condensation rain of warm filaments and molecular clouds. In the nuclear region, the recurrent collisions between the clouds and filaments boost the SMBH accretion rate via Chaotic Cold Accretion (CCA). The CCA rapid variability triggers powerful ultrafast AGN outflows near the SMBH horizon, which propagate outwards and form entrained multiphase winds at the kpc scale. I highlight the key imprints of AGN feeding and outflow feedback and how the different phases are interconnected in terms of both kinematics and thermodynamics.

ACTIVE GALACTIC NUCLEI / 419

X-ray Spectral Fitting of AGNs in XMM-COSMOS with a Bayesian Hierarchical Method

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We present our results of fitting 663 X-ray spectra of AGN sources in the XMM-COSMOS field detected in 2-7 keV band, all of which have a spectroscopic redshift. We developed a new approach based on a Bayesian hierarchical model in order to correctly propagate on the main spectral parameters like Gamma and Nh the uncertainties due to the presence of additional, ill-constrained components like reflection and soft-excess, that are present in the X-ray spectra of AGN. Realistic simulations of AGN spectra have been created and analysed to validate our approach and identify the limitations in the recovery of the main parameters. Using the measured probability distributions and a Bayesian hierarchical model for the parent properties, we determine the distribution of the hydrogen column density as a function of redshift, and we study the dependence of the obscured AGN ratio on the source luminosity.

ACTIVE GALACTIC NUCLEI / 420

X-ray observations of IR selected AGN

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We study the X-ray properties (using XMM-Newton) of mid-infrared (mid-IR) selected AGN. For that purpose, we use WISE sources in the Stripe82-XMM area to identify mid-IR AGN candidates, applying the Assef et al. criteria.
XMM-Newton observations cover 26 deg2. Our sample consists of 1946 IR AGN candidate and about 1/3 is detected in X-rays. 1507 have SDSS detection and 824 sources have optical spectra. We also use optical to mid-IR photometry to construct Spectral Energy Distribution (SED) for the 1507 IR AGN with SDSS detection. The SED analysis indicates that only 1/3 of the sources are type-1 based on the inclination angle. Previous studies have found a correlation between optical/IR colours (r-W2) and AGN obscuration. The AGN population detected by SDSS presents two peaks in the r-W2 distribution while the X-ray detected sources do not cover the second redder r-W2 peak. Therefore, it appears that at the X-ray fluxes depth probed, X-rays miss the most optically absorbed sources. We apply X-ray spectral fitting to estimate the obscuration (NH) for the ~500 X-ray detected AGN and we compare with the obscuration found by the SED method.

ACTIVE GALACTIC NUCLEI / 421

Hunting for X-ray Quasi-Periodic Eruptions: discovery of a second QPE active galactic nucleus

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Quasi-Periodic Eruptions have been recently discovered in the nucleus of the low-mass black hole galaxy GSN 069. QPEs are abrupt increases in the X-ray count rate over a quiescent flux level, and recur quasi-periodically every few hours (Miniutti et al. 2019, Nature in press). Thanks to a new XMM-Newton observation performed at the end of May 2019, we have discovered X-ray QPEs in a second active galactic nucleus, RX J1301.9+2747. We present the general temporal and spectral properties of the X-ray QPEs, together with some possible interpretations for this new physical phenomenon. QPEs could be key to understand puzzling aspects of the physics of accretion around super massive black holes, such as the fast variability displayed by the changing-look AGN, or the formation of the soft X-ray excess.

ACTIVE GALACTIC NUCLEI / 422

A global scenario for accretion/ejection around super massive black holes: the X-ray view

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In the global scenario proposed by Giustini & Proga (2019), most of the diversity observed in AGN can be explained by different accretion/ejection flows, which depend on the Eddington ratio and on the black hole mass, and therefore on the presence or absence of accretion disc winds driven by radiation pressure.
X-ray observations are crucial to test this scenario: in fact, they allow to constrain the physical properties of both the intrinsic continuum emission region and of the intervening outflowing absorbers, when the most powerful accretion disc winds are intercepted by the line of sight.
We present the current status of the X-ray observations that are able to probe, and therefore prove or disprove, the global scenario proposed by Giustini & Proga; we will then discuss the enormous future observational perspectives given by the X-ray microcalorimeters onboard XRISM and, next and fundamental, ATHENA.

ACTIVE GALACTIC NUCLEI / 423

Scattered X-Ray Radiation in Obscured Active Galactic Nuclei

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Accreting supermassive black holes, also known as active galactic nuclei (AGN), are surrounded by large quantities of gas and dust. Based on the column density of the material in the line of sight, AGNs can be classified as obscured and unobscured. In the case of obscured AGNs, the torus depletes most of the light produced by the accreting black hole and a useful way to study them is in the X-rays, which can penetrate large column densities. By utilizing the data provided by the 70-month Swift/BAT all-sky survey in the hard X-ray regime (14-195 keV), we study the properties of Thomson scattered X-ray radiation for a sample of local ($z<0.1$) AGNs and the relation between the fraction of scattered radiation and the physical properties of the black hole.

ACTIVE GALACTIC NUCLEI / 424

ANEPD-CXO245: A COMPTON THICK AGN WITH DOUBLE-PEAKED NARROW LINES

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ANEPD-CXO245: A COMPTON THICK AGN WITH DOUBLE-PEAKED NARROW LINES.
In our multi-wavelength survey of the AKARI North Ecliptic Pole Deep Field, including X-ray observations obtained with Chandra (Krumpe et al. 2015), we have found a highly absorbed AGN (ANEPD-CXO245, hereafter CXO245; $z = 0.449$) that shows double-peaked narrow emission lines. The X-ray spectrum of CXO245 from our Chandra observations shows a prominent redshifted Fe Kα emission line at 6.4 keV with an equivalent width EW ≥ 2 keV (both in rest-frame). Our X- ray spectral analysis using the borus02 (Balokovic et al. 2018) AGN torus model shows that the torus/line-of sight column density of $\log(N_H) = 24.3 - 25.4$ (90% confidence) and thus it can be classified as Compton-thick.
In order to distinguish among possible explanations for this behavior (a dual AGN, a rotating ring around the central black hole, or the view of the two sides of a bi-polar outflow), constraints on the opening angle of the obscuring dusty torus (θ_{tor}), as well as the line-of-sight (LOS) inclination (θ_{inc}) are important. We obtained the constraints on these torus parameters by (1) fitting our multi-wavelength SED (optical-IR) with the CIGALE SED analysis package (Noll et al. 2009), using an AGN torus emission component (Fritz et al. 2006) and (2) fitting the Chandra spectrum with borus02.
The results obtained with both the optical-IR and X-ray analyses consistently show that and θ_{inc} is only slightly larger than θ_{inc} (both from the torus polar axis), i.e., the LOS is just below the inner funnel of the torus. However, the constraints on θ_{inc} and θ_{tor} are highly degenerate, and deeper observations in the X-ray regime are required to obtain individual constraints. We also report the results of the analysis using the Clumpy Torus model (Nenkova 2008) in combination with the new XCLUMPY model (Tanimoto et al.).

ACTIVE GALACTIC NUCLEI / 425

X-ray properties of z>4 blazars

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We present the X-ray properties of a complete and well-defined sample of 24 high-z (z=4-5.5) blazar candidates selected from the CLASS radio survey. After completing the existing archival data (Swift-XRT, Chandra and XMM-Newton) with dedicated Swift-XRT observations, we identified the bona-fide blazars based on the X-ray intensity (compared to the optical one) and flatness of the spectrum. We then compared their X-ray-to-radio luminosity ratios with a sample of confirmed blazars at lower redshifts (¯ =1.1), finding a significant difference in the two populations. We interpret this redshift-dependant evolution as due to the interaction of the electrons within an extended part of the jet with the Cosmic Microwave Background photons.

ACTIVE GALACTIC NUCLEI / 426

RELTRANS: A public model for X-ray reverberation mapping of accreting black holes

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I will present the publicly available XSPEC model RELTRANS. The model calculates the light-crossing delays and energy shifts experienced by X-ray photons originally emitted close to the black hole when they reflect from the accretion disk and are scattered into our line-of-sight, accounting for all general relativistic effects. The model is fast and flexible enough to be simultaneously fit to the observed energy-dependent cross-spectrum for a large range of Fourier frequencies, as well as to the time-averaged spectrum. This not only enables better geometric constraints than only modelling the relativistically broadened reflection features in the time-averaged spectrum, but additionally enables constraints on the mass of supermassive black holes in active galactic nuclei and stellar-mass black holes in X-ray binaries. The model includes a self-consistently calculated radial ionization profile in the disk. I will show that the inclusion of this profile makes a significant difference to the parameters inferred from data through the example of a NuSTAR observation of the X-ray binary GRS 1915+105. I will also present model fits to the lag-energy spectrum of the Seyfert galaxy Mrk 335 that result in a best fitting black hole mass that is smaller than previous optical reverberation measurements (~7 million compared with ~14-26 million solar masses). I will discuss how in future X-ray and optical reverberation analyses can be combined to constrain the geometry of the X-ray emitting corona and the broad line region.

ACTIVE GALACTIC NUCLEI / 427

Spectral atlas of the XMM-CDFS deep survey

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XMM-Newton observed the Chandra Deep Field South (CDFS) with a ~3 Ms exposure time. EPIC spectra of bright 185 sources, practically all AGN with redshift up to z=3.8 , are compiled and their basic properties are studied by conventional spectral fitting, as well as an exploratory analysis with two, rest-frame X-ray colours and the Fe K line strength indicator and rest-frame spectral stacking. A significant proportion of the sample shows X-ray absorption, as expected. The nH distribution agrees with that has been found in various X-ray surveys. We find a Compton thick AGN fraction to be ~4%. Obscured AGN fraction shows a clear evolution and we attribute it to increasing gas content in galaxies towards high redshift. For unobscured AGN, broad Fe K line detection rate is ~30% in the brightest 21 subsample. The anti-correlation between the narrow Fe K EW and Lx (or the Iwasawa-Taniguchi effect) found in nearby AGN is not present in the XMM-CDFS unobscured AGN. However, this is probably due to a combination of the Lx-z bias and the evolution of the galaxy gas content suggested above.

ACTIVE GALACTIC NUCLEI / 428

On the origin of steep emissivity profiles in AGN accretion discs

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X-ray observations suggest high compactness of coronæ in active galactic nuclei as well as in X-ray binaries. The compactness of the source implies a strong radial dependence in the illumination of the accretion disk. This will, for any reasonable radial profile of the density, lead to a radial profile of the disk ionization. Thus, an artificial increase of the radial emissivity parameter can be seen by assuming a radially structured ionization profile of the disk. We have investigated the effect of radial ionization profiles on the observed X-ray spectra and quantified it for a wide range of parameters. In this talk, I will present the results obtained from simulations which were carried out with the current state-of-the-art models for relativistic reflection. We simulated spectra using the response files of the microcalorimeter X-IFU, which is planned to be on board of Athena. We assumed typical parameters for X-ray bright Seyfert-1 galaxies and considered two scenarios for the disk ionization: (1) a radial profile for the disk ionization and (2) a constant disk ionization. Our results suggest that steep emissivity profiles can be indeed achieved due to the radial profile of the disk ionization, which becomes more important for the cases where the corona is located at low heights above the black hole and this effect may even be more prominent than the geometrical effects. We also discuss how this might affect black hole spin measurements.

ACTIVE GALACTIC NUCLEI / 429

A hard look at local Seyfert 2 galaxies with NuSTAR

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Current measurements show that the observed fraction of Compton-thick (CT) active galactic nuclei (AGN) is smaller than the expected values needed to explain the cosmic X-ray background. Thanks to its unprecedented sensitivity covering the 3 - 79 keV band, NuSTAR is playing a key role in identifying the missing fraction of these sources and determining their properties. In this talk, I will present the first results of the "NuSTAR Obscured Seyferts Survey" aiming to study an optically-selected volume-limited sample of 22 Seyfert-2 galaxies that were identified in the CfA Redshift Survey. This NuSTAR legacy survey will allow us to accurately measure the obscuring column densities, Eddington fractions and other fundamental properties of these sources. This would be accomplished by using physically motivated spectral models to fit the X-ray spectra of these obscured sources, which will additionally provide better insights on the geometry of the obscuring material. I will introduce the sample, describe the various spectral models employed in this work, and discuss the physical implications of our results. I will also discuss how future high-resolution X-ray observatories such as XRISM and Athena will improve our understanding of CT AGN in the soft X-rays.

ACTIVE GALACTIC NUCLEI / 430

Nuclear activity in nearby quasars

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Nuclear activities of 67 nearby quasars show the bolometric correction factor is correlated with their accretion rate, both in infrared (IR), optical, and X-ray. We present a comprehensive study of the full AGN intrinsic spectral energy distributions (SEDs) of 67 redshift < 0.5 quasars selected from the Palomar-Green sample, using spectroscopies from XMM-Newton, HST , SDSS and photometric measurements from the Optical Monitor (OM) of XMM-Newton . The properties of the underlying accretion disc are studied after the proper subtraction from emission lines, pseudo-continuum and host galaxy. By imposing more physical conditions for the modeling, this approach can estimate the black-hole accretion rate more robustly, which is crucial to study the coevolution of black holes and galaxies.

ACTIVE GALACTIC NUCLEI / 431

The soft gamma-ray sky observed with INTEGRAL's IBIS-PICsIT detector

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Multi-messenger astronomy entered a new phase after the detection of gravitational waves, fast radio bursts and a recent progress in the neutrino astrophysics. It is evident that the observations over the whole electromagnetic domain become more and more important. Deailed spectral information in the soft gamma-ray band (100 keV - 100 MeV) is essential to study the physical processes responsible for the non-thermal emission, e.g. the jet physics or antimatter annihilation.
The IBIS high energy detector PICsIT on board INTEGRAL satellite is one of the few instruments observing currently the sky in the soft gamma-ray band since 2002. Thanks to the coded-mask technique the PICsIT's angular resolution is unprecedented. Despite the high instrumental background, due to cosmic rays, a careful, fully-Bayesian data analysis allowed to detect several dozens of high-energy sources, providing unique results in the 240-1000 keV energy range.
In this review a spectral catalog of all detected objects will be presented. Examples of the modeling of the spectra will be shown with an emphasis to the broad-band study for a diagnosis of the non-thermal plasma and jet emission in various accreting systems such as bright Active Galactic Nuclei, transient and persistent galactic black holes. In addition, the presence of the positron annihilation features will be addressed for several objects.

ACTIVE GALACTIC NUCLEI / 432

X-ray winds with the WINE model: a detailed photoionization treatment of relativistic outflows in quasars

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Ultra-fast outflows (UFO) in the X-ray band are now observed in about half of active galactic nuclei (AGN). They are likely launched at accretion disk scales with relativistic speeds (around 0.1-0.3 c), and can reach a very high mechanical power. However, up to now very little is known about the physics behind these extreme phenomena, including the launching mechanisms and their geometry. So far, mostly absorption profiles have been modeled and compared with observations.
To gain new insights from the data, we developed a new spectral model describing both absorption and emission from a photoionized wind. A first version of the model has been applied to the UFO in the nearby ($z = 0.184$) and luminous ($L_{bol} = 10^{47}$erg/s) quasar PDS456 (Luminari et al. 2018), with promising results.
Particular attention is devoted to the wind kinematic and geometry, including the covering fraction and the inclination of the wind with respect to the line of sight. Moreover, the radiative transfer code XSTAR, which is now included in the model, allows us to take accurately into account the photoionization equilibrium of the wind with respect to its density and velocity profiles.
Relativistic effects have also been modeled carefully, using a first-principle approach. This leads to a sensitive improvement of the simulated spectra already for moderate outflowing velocities ($0.01c$), and generates important effects for high UFO velocities of $\sim$0.1-0.2c.
The spectral diagnostics of the model will allow to fully exploit the unprecedented energy resolution of the upcoming X-ray observatories XRISM and ATHENA.
This work is done in collaboration with Prof. F. Tombesi and F. Vagnetti (Univ. of Rome "Tor Vergata), Dr. E. Piconcelli (INAF - Rome), Prof. K. Fukumura (J. Madison University, USA) and Dr. D. Kazanas (GSFC/NASA, USA).

ACTIVE GALACTIC NUCLEI / 433

Radio morphology-accretion mode link in FRII low-excitation radio galaxies

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Radio Galaxies (RG) are Radio-Loud Active Galactic Nuclei (AGN) characterized by powerful relativistic jets, oriented at relatively large inclination angles with respect to the observer's line of sight. They are extraordinarily relevant to address important issues such as the interaction between Super Massive Black Holes, the radio jets and their environment.
RGs are commonly classified on the basis of their radio morphology into low radio power FRI (core-dominated) and high radio power FRII (lobe-dominated). Almost all FRIIs hide an efficient accretion disk, while the central engine of FRIs is probably an ADAF, suggesting a strong link between ejection of relativistic plasma and accretion. However, there is a group of FRII sources
that does not fit into this picture. They exhibit powerful extended radio structures but inefficient accretion, as attested by their low excitation optical spectra.
In order to investigate their nature, an X-ray systematic analysis of all FRIIs belonging to the 3CR sample with z < 0.3 and available Chandra and XMM-Newton observations was performed. We investigate different scenarios and conclude that the evolutionary one is the most probable. FRII-LERGs have indeed intermediate properties (X-ray luminosity, column density and accretion rate in terms of Eddington luminosity) with respect to classical FRIIs and FRIs.
The nuclear power seems to suffer of a depletion of the cold gas reservoir. It is then plausible to think that this information has not yet reached the large-scales radio structures at kpc distances from the central engine. The powerful lobes are the heritage of a past AGN activity at higher efficiency.

ACTIVE GALACTIC NUCLEI / 434

A multi-observatory X-ray approach to characterize heavily obscured AGN

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According to the different models of Cosmic X-ray Background (CXB), the diffuse X-ray emission observed in the 1 to ~200-300 keV band, is mainly caused by accreting supermassive black holes, the so-called active Galactic Nuclei (AGN). Particularly, at the peak of the CXB (~30 keV) a significant fraction of emission (10-25%) is expected to be produced by a numerous population of heavily obscured, Compton thick (CT-) AGN, having intrinsic column density NH>=1E24 cm^(-2). Nonetheless, in the nearby Universe (z<=0.1) the observed fraction of CT-AGN with respect to the total population appears to be lower than the one expected on the basis of the majority of CXB model predictions (~20-50%), being between 5 and 10%. This discrepancy between data and models is one of the open challenges for X-ray astronomers, and needs to be solved to get a complete understanding of the AGN population.
In this presentation, I will discuss a multi-observatory X-ray approach to find and characterize heavily obscured AGNs. The starting point of the project is the 100-month Swift-BAT catalog, the result of a ~7 years all-sky survey in the 15-150 keV band and a powerful tool to select and identify nearby, heavily obscured AGNs.. These objects are then targeted with snapshot (5-10 ks) observations with Chandra and Swift-XRT, which allow us to constrain the intrinsic absorption value within a 20-30% uncertainty. Finally, deep (25-50 ks) observations with XMM-Newton and NuSTAR allow us to study the physics of these complex and elusive sources.

ACTIVE GALACTIC NUCLEI / 435

Tracking the Iron Kα line and the Ultra Fast Outflow in NGC 2992

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Variability is one of the best tools to investigate the emission mechanisms in Active Galactic Nuclei (AGN). We report on the 2010 XMM-Newton monitoring of the highly variable Seyfert 2 Galaxy NGC 2992, which was subsequently targeted by Swift and NuSTAR in 2015. XMM-Newton always caught the source in a faint state but NuSTAR observed a brightening of the source, with evidence of an Ultra Fast Outflow with velocity v=0.21±0.01c. A re-analysis of the high flux 2003 XMM data confirmed the presence of such a highly ionized accretion disk wind, with two distinct outflowing velocities (v1=0.215±0.005c and v2=0.305±0.005c). The UFO in NGC 2992 is consistent with being ejected at a few tens of gravitational radii only at accretion rates greater than 2% of the Eddington luminosity.
The analysis of the XMM data also allowed us to determine that the Iron Kα emission line complex in this object is likely the sum of three distinct components: a constant, narrow one due to reflection from cold, distant material (likely the molecular torus); a narrow, but variable one which is more intense in brighter observations and a broad relativistic one emitted in the innermost regions of the accretion disk.

ACTIVE GALACTIC NUCLEI / 436

Completing the new generation of Chandra Extragalactic Surveys with the Chandra Deep Wide-Field Survey

Author(s): Alberto Masini[1] ; Ryan Hickox[1]

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X-ray surveys are one of the most efficient ways to detect active galactic nuclei (AGN) and perform statistically meaningful population studies. In the past decade, important results in this field came from both wide and deep X-ray surveys of the sky, performed following the well-known “wedding cake” approach.
Thanks to these surveys, there is now compelling evidence that there is a strong connection between the growth of Black Holes (BHs) and the evolution of large-scale structures.
To further test this picture, the Chandra Deep Wide Field Survey (CDWFS) was designed, able to probe large volumes and detect large numbers of AGN at the luminosities and redshifts that comprise the bulk of the growth of BHs. Indeed, the CDWFS pushes deeper the wide layer of the “wedding cake”, to align with the sensitivity-area locus of the most recent Chandra surveys.
In this talk, the status of the survey and its perspectives will be discussed: we will take advantage of the exquisite Chandra angular resolution and sensitivity in order to study in detail the large-scale clustering of AGN and their Eddington-ratio distribution, to probe the AGN-Dark Matter halo and AGN-Star Formation connections.

ACTIVE GALACTIC NUCLEI / 437

Solving the hard X-rays excess in the NLSy 1 TON S180

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We present a detailed analysis of a joint *XMM-Newton & NuSTAR* observation of the nearby ($z = 0.062$) luminous NLSy 1 galaxy TON S180 taken in 2016. We find that the observed steep soft excess is likely produced by Comptonization rather than relativistic reflection. By analyzing the broadband SED from 1 eV to 35 keV, we find that the overall intrinsic properties of the continuum can be accounted for by thermal emission from the disc (UV) plus Comptonized emission from the corona at a high fraction ($\sim 70\%$) of the Eddington limit. We also find that there is a weak contribution of disc reflection with a moderate black hole spin.

ACTIVE GALACTIC NUCLEI / 438

Extended X-ray Emission Near PG1407+265

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We report Chandra observations of the environment of the unusual redshift 1 quasar PG1407+265 and discuss a new X-ray cluster found 1 arcminute from it. We discuss the X-ray variability of the quasar and estimate the cluster contribution to the X-ray flux in previous lower resolution observations. Optical observations complement the Chandra data and allow us to estimate the physical properties of the cluster.

ACTIVE GALACTIC NUCLEI / 439

The XMM-Newton and NuSTAR monitoring campaign of MrK 359: a close view of the inner flows

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We conducted a broadband multi-epoch campaign to observe the nearby Narrow Line Seyfert 1 galaxy Mrk 359. The monitoring consisted in 5 simultaneous XMM-Newton/NuSTAR observations (50 ks each) over a timescale of 10 days. During the campaign, Mrk 359 showed significant intra-observation variability, as well as among the pointings. Changes in the spectral slope occurred down to days timescales. A remarkable and variable soft-excess dominates the soft X-ray band.
Besides a prominent and variable Fe Kalpha emission line, statistically significant absorption features at higher energies are also observed suggesting the presence of outflowing material.
We report on the broadband phenomenological modelling which reproduces the data-set, with particular emphasis on physically motivated Comptonisation models in a two-corona scenario. Finally, the obtained results on Mrk 359 will be discussed and compared with outcomes from similar monitorings performed in the past.

ACTIVE GALACTIC NUCLEI / 440

A simple model to explain apparently complicated X-ray spectral variation of NGC5548

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NGC5548 is known to exhibit complicated X-ray spectral variations such that double partial covering layers may have different covering fractions and that one of the fractions correlates with the photon-index of the power-law component (Cappi et al. 2016). It is hard to understand such a correlation between the two parameters that should be physically independent.

Here, we propose a simple model to explain the apparently complicated X-ray spectral variation of NGC5548. In our model, the continuum spectrum from the central region is a cut-off power-law dominant above ~1 keV with a soft excess below ~1 keV (which may be expressed with the disk black body model). The X-ray emission region is fully covered by a highly ionized inner-wind and partially covered by an outer-clumpy absorbing layer, where each clumpy absorber is composed of the cold-core and a warm-layer; thus the "double partial covering" takes place with the same covering fraction.

In addition, we assume a cold outer-disk reflection component accompanying a narrow Fe emission line, and a thermal plasma component from the host galaxy; these components are not affected by the local absorbers.

We conducted extensive spectral study of NGC 5548 using XMM, Suzaku and NuSTAR in 0.3-78 keV in timescales from ~1000 sec to ~16 years. As a result, we found that most of the observed spectral variation over these timescales is explained by only variations of (1) the soft excess spectral component, (2) power-law normalization, and (3) partial covering fraction of the clumpy absorbers. The soft excess component is significantly variable over timescale of years, but rather stable in shorter timescales.

While the power-law normalization is moderately variable by a factor of ~3 in various timescales, the partial covering fraction is significantly variable from 0 (not covered at all) to ~0.98 (almost fully covered). The power-law photon-index, as well as other spectral parameters are hardly variable despite of apparently significant spectral variations.

Our model is consistent with the previous studies, where "Variable Double Partial Covering model" (Iso et al. 2016), explains spectral variations of 20 Seyfert galaxies observed by Suzaku in 2-70 keV, and the "hot-inner and outer-clumpy wind model" (Mizumoto et al. 2019) explains the Fe-K line lags commonly observed in Seyfert galaxies such as 1H0707-495 and Ark564.

In addition, our model successfully explains wide-band spectral variations of MCG-6-30-15, NGC4593, NGC1365, Swift J2127.4+5654 and MCG-5-23-16 simultaneously observed by XMM-NuSTAR (Ebisawa et al. in this conference).

ACTIVE GALACTIC NUCLEI / 441

AGN Clustering and Halo Occupation Distribution from X-ray surveys

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Clustering of AGNs give additional clues to understanding the physical processes of supermassive black hole accretion. The strength of large scale clustering (bias parameter) gives a typical mass of Dark Matter Halos (DMHs) in which the AGN live in. Small scale clustering give additional clues on how the AGNs distribute among DMHs through Halo Occupation Distribution (HOD) modelings. We present the results of our series of AGN clustering measurements using two-point crosscorrelation function (CCF) of ROSAT All-Sky Survey/Swift BAT AGNs with galaxy samples and their HOD modelings.

We emphasis on the results of our recent CCF measurements between Swift BAT AGNs and 2MASS redshift-survey galaxies in the local universe (z<0.037) and those between RASS (SDSSIV-SPIDERS) AGNs and BOSS-CMASS galaxies at z~0.55. The new results include the findings that: (1) the typical DMH masses from the biases of the local Swift BAT AGNs ($42 \log L_{14\text{-}195\mathrm{keV}} < 44$) type 1 and type 2 AGN samples are similar (M_{DMH}~$10^{13} h^{-1}$Msun), which is also close to our previous results for z~0.3, $\log L_X$ erg s-1 ~44) RASS AGNs (2) the small scale clustering (the one-halo term regime) is suppressed in the type I AGN only, that may imply that the type I AGN fraction among galaxies decrease with increasing DMH mass, as we found for the $z\sim 0.3$ RASS AGNs. This tendency has not been observed with the type 2 AGN sample.

We also discuss the implications of our results by comparison them with AGNs in cosmological simulations under a few scenarios.

ACTIVE GALACTIC NUCLEI / 442

The origin of UFOs in AGN

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UltraFast Outflows (UFO) are seen in some active galactic nuclei (AGNs), with blueshifted absorption lines of highly ionised iron ion. AGN typically has a UV-bright accretion flow, so UV line driving is an obvious candidate for launching these winds. However, it requires that material in the acceleration zone has substantial UV opacity, in conflict with the observed very high ionisation state of the wind. We use a state of the art UV line driven wind simulation (full radiation hydrodynamics), and demonstrate that there are some lines of sight which only intercept fast and highly ionised material. The cooler material required for the acceleration is out of the line of sight, close to the disc, shielded from the X-rays by a failed wind. We show that resonance line scattering in the wind can reproduce the broad Fe-K feature seen in the lag-energy spectra. New data from the microcalorimeters will allow us to test this, paving the way for a physical model of the mass loss rate of UFOs.

ACTIVE GALACTIC NUCLEI / 443

The unusual suspects. A new population of X-ray weak quasars at high redshift.

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We have recently obtained deep XMM-Newton observations of 30 bright quasars, selected in the optical from the SDSS-DR7 to be representative of the most luminous, intrinsically blue quasars at high redshift ($3.0 < z < 3.3$). Despite the uniform selection in terms of optical/UV spectral properties and the narrow range of luminosity, black-hole mass and accretion rate probed by our sample, two distinct populations surprisingly emerge from the X-ray analysis: about two thirds of the targets perfectly follow the well-established, non-linear UV vs. X-ray luminosity relation, while the remaining one third lie significantly below the expectations. The X-ray spectra of the latter sources are flatter and show no evidence of absorption, suggesting a different disc/coronal state. As our sample picks the kind of objects where radiative feedback is supposed to be most intense, we argue that intrinsically X-ray weak quasars (i.e. emitting much less in the X-rays than dictated by the X/UV relation) are currently undergoing a blow-out phase, during which a substantial fraction of the gravitational energy is dissipated to drive a powerful accretion-disc wind, thus starving the corona. This result provides novel insights into the nature and incidence of X-ray weakness in quasars, and its physical link to the most critical phases of galaxy evolution.

ACTIVE GALACTIC NUCLEI / 444

The Hunt for UFOs with Chandra-HETGS

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Ultra-fast Outflows in AGN were first suggested based upon low spectral resolution CCD data in the 6-8 keV range, and were ascribed to absorption by highly ionized Fe. In this region, CCD resolution isn't dramatically below that of gratings. Further evidence for UFOs has been claimed from high spectral resolution observations with the XMM-Reflection Gratings Spectrometer, and has been extended to Ultra-Luminous X-ray sources. The <2 keV region, however, is extremely crowded, and UFO models often posit multiple absorbers with a range of blueshifts. It is not clear that even RGS resolution suffices. I discuss two recent UFO studies using the Chandra-HETGS. We gain from improved resolution, but suffer from low effective area. First, for the AGN PG1211+143, we were able to verify the presence of an absorber outflowing at 0.06 c. Next, for the ULX NGC 1313 X-1 we are still trying to determine if there is evidence for a UFO, and if not, do our observations contradict prior RGS studies?

ACTIVE GALACTIC NUCLEI / 445

Reflection from AGN disks and surroundings, Unification and the CXB

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Compton thick (CT) AGN are predicted by unified models, which attribute most of the AGN diversity to their inclination, and play an important role for the understanding of the growth of black holes in the early Universe. The fraction of CT AGN at low redshift can be derived from the observed CXB spectrum assuming AGN spectral templates and luminosity functions. We show that high signal-to-noise average hard X-ray spectra, derived from Swift/BAT and NuSTAR, imply that mildly obscured Compton thin AGN feature a strong reflection and contribute massively to the CXB. Thus, a population of CT AGN larger than that effectively detected is not required. The strong reflection observed in mildly obscured AGN, even in individual NuSTAR observations, suggests that the covering fraction of the gas and dust surrounding their central engines is a key factor in shaping their appearance. In addition, NuSTAR observations of AGN show clearly that the reflection behavior varies with the obscuration. The disk is found to be the main reflector in unobscured sources. Instead, obscured objects feature a correlation between reflection and column density, a characteristic of a clumpy reprocessing region located far away.

ACTIVE GALACTIC NUCLEI / 446

Disentangling the dependence of AGN variability on physical parameters in the Chandra Deep Field South

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We explore the dependence of Active Galactic Nuclei from the BH mass and luminosity for the ~30 supermassive BHs with mass estimates in the Chandra Deep Field south. With this dataset we can test wether the results are consistent with the models based on low-redshift AGNs, and validate the use of AGN variability to estimate the accretion history of SMBH as well as for future cosmological applications.

ACTIVE GALACTIC NUCLEI / 447

The X-ray view of the repeat changing-look AGN NGC 1566

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Co-author(s): Norbert Schartel [2] ; Dirk Grupe ; S. Komossa [3] ; Fiona Harrison ; Wolfram Kollatschny ; Rebecca Mikula ; Maria Santos-Lleo ; Laura Tomas

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NGC 1566 is one of only a handful of AGN that have undergone more than one changing-look event, having changed from Sy 1.9 to Seyfert 1.2 and at least five times. The most recent event was in 2018, where the source increased in X-ray flux by a factor of ~70 and nearly three magnitudes in the UV in under 9 months, coinciding with the reappearance of strong broad lines in the optical spectra.
For the first time, high quality X-ray spectra were taken at the peak of the outburst. The spectra show a classic Seyfert 1 X-ray spectrum, with a soft excess, compton hump, and iron line, as well as outflowing absorption in the high-resolution RGS spectrum. The remarkable speed with which this 'standard' AGN develops, and the repeating nature, offers a unique insight into the changing look phenomenon.

ACTIVE GALACTIC NUCLEI / 448

Obscured AGN in the field of J1030+0524: the X-ray and optical/infrared perspective

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I will present the X-ray spectral analysis of a sample of obscured AGN candidates in the 17'x17' field surrounding the bright $z = 6.31$ QSO SDSS J1030+0524, observed for 500ks with *Chandra* ACIS-I. The sample objects are selected to have an hardness ratio $HR > -0.1$, suggestive of the presence of moderate to heavy obscuration ($10^{22} \leq N_H \leq 10^{24}$ cm^{-2}), and a range of net counts (i.e. background subtracted) from a few tens to hundreds, with a median of ~ 80.
The main goal is to place constraints on the redshifts of the sources, using a multiwavelength approach. Firstly, the analysis has been carried out using X-ray spectroscopy, searching for strong features like the iron $K\alpha$ 6.4 keV emission line and/or the 7.1 keV absorption edge, that is expected to be very deep in obscured objects. Because of the low photon statistics, the resulting X-ray redshift solutions have also been verified using state-of-the-art simulations. Then, using the large photometric coverage in optical/NIR/MIR bands (LBT, CFHT, CTIO and *Spitzer* data), independent solutions are calculated performing photometric redshifts.
The comparison between the X-ray and photometric methods can be an efficient tool to estimate redshifts of high-z obscured AGN, which are usually weak in optical/NIR, possibly making the spectroscopic identification challenging. The obtained redshifts are used to identify the physical properties of the sample, such as the intrinsic luminosity and the absorption column density, as well as the properties of the host galaxies in which the obscured AGN candidates reside.
Furthermore, based on an ongoing optical spectroscopic campaign at the LBT, I am confirming the goodness of this method, which will be useful for future X-ray mission like *eRosita* and *Athena*, but also in other deep fields like the CDF-S, where a fraction of X-ray sources (5%) are still not detected in other bands.

ACTIVE GALACTIC NUCLEI / 449

Nature of the coronal emission in Active Galactic Nuclei

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The X-ray spectrum from the corona of an AGN is generally approximated as a power law up to certain energies after which the spectrum turns over called as cut-off energy. Thus, the two main observables in the X-ray spectrum of an AGN are the power law photon index and the energy at which the cut-off occurs. This high energy cut-off is a manifestation of the temperature of the electrons in the corona which is inferred to be around 2-3 times the electron temperature. Therefore, constraining the temperature of the corona in AGN is very important to understand the physical processes happening close to their central regions. Observations from INTEGRAL and Swift/BAT have provided high energy cut-off measurements (found to be at around tens of keV) in a few AGN, however, with large uncertainties. Observations with NuSTAR is better poised to provide measurements of the coronal temperature of AGN owing to its focusing capability and better sensitivity compared to INTEGRAL and Swift/BAT. To determine the physical parameters of the corona, it is very important to have broadband X-ray data. Towards this, we have selected a sample of Seyfert galaxies having NuSTAR data and have combined this with data from Suzaku and XMM. Simultaneous model fits were performed to derive the coronal properties of our sample. Results of this systematic study will be presented at the meeting.

ACTIVE GALACTIC NUCLEI / 450

Quasars as standard candles

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The non-linear X-ray to UV relation in quasars can be used to estimate their luminosity. Our analysis of a sample of several thousand quasars with SDSS spectra and X-ray serendipitous observations shows that, quite unexpectedly, the observed dispersion of the relation is almost entirely due to observational effects, while intrinsically the relation holds with a very small dispersion -lower than 0.1 dex- on five orders of magnitudes in luminosity, and over the whole z=0-7 range. This implies that (1) a universal physical mechanism links the accretion disk and the UV-emitting corona, and (2) quasars can be turned into standard candles, and used to measure the expansion of the Universe at high redshift.

ACTIVE GALACTIC NUCLEI / 451

X-ray analysis of the accreting supermassive black hole in the radio galaxy PKS 2251+11

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The launch and the propagation of relativistic outflows from supermassive black holes is one of the main unresolved issues in the field of active galactic nuclei (AGNs). Radio galaxies are optimal candidates for a multi-wavelength study of the connection between accretion phenomena and the ejection of energetic outflows. In this regard, we focus on the active galaxy PKS 2251+11, a particularly bright broad line radio galaxy, for which we have investigated the structure, kinematics and physical state of the nuclear environment, through an X-ray spectral and temporal analysis of an XMM-Newton observation. The results are interpreted in light of the unified model of AGNs, comparing the accretion properties of PKS 2251+11 with the larger class of radio-quiet Seyfert galaxies.

ACTIVE GALACTIC NUCLEI / 452

Radio bimodality of Swift/BAT AGNs and SDSS quasars

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Comparison of properties of quasars with those of low redshift AGNs with similar BH masses but accreting at much lower accretion rates provides exceptional opportunity to study the dependence of the properties of these massive accretion systems on the specific accretion rate. This particularly concerns abilities of such systems to produce powerful jets. We present here results of comparison of radio-loudness distributions and discuss them in the context of investigated in literature scenarios proposed to explain the radio-dichotomy of AGN. Our preliminary results indicate that: (1) there is an explicit bimodality in the radio-loudness distributions in both populations; (2) the radio-loud fraction of AGNs accreting at moderate rates is larger than of quasars. These differences are consistent with predictions of the MAD (magnetically-arrested-disk) scenario for the production of strong jets and favor the model according to which central accumulation of magnetic flux proceeds prior to the AGN/quasar event.

ACTIVE GALACTIC NUCLEI / 453

The X-ray/UV luminosities relation in high-redshift quasars

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A tight non-linear relation between the X-ray and optical-ultraviolet emission has been observed in unobscured Active Galactic Nuclei (AGN) over several orders of magnitude in luminosity and irrespective of the sample selection, suggesting a universal coupling between the disk, emitting the primary radiation in the UV band, and the hot corona emitting in the X-ray.
Recently, our group developed a method to use the non-linearity of the relation to estimate the absolute luminosity of quasars, turning them into standardizable candles.
In this regard, we investigated the presence of potential systematics of this correlation at high redshift; studying the L_X-L_{UV} relation for a sample of 55 $z > 4$ quasars, selected on the basis of their spectral properties and the quality of the available observations in both X-ray and optical/UV bands. We found that the relation shows no-evidence for evolution with redshift, implying that the physical mechanism regulating the energy transfer between the accretion disc and the X-ray emitting corona has to be ubiquitous, hence allowing the use of quasars in observational cosmology.

ACTIVE GALACTIC NUCLEI / 454

Unveiling multiphase quasar-driven outflows in PG 1114+445

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Supermassive black hole (SMBH) winds are believed to be a key player in the evolution of galaxies. In fact, outflows from active galactic nuclei (AGN) may be one of the fundamental mechanisms by which a SMBH transfers a significant fraction of its accretion energy to the surrounding environment. Disk-scale ionized ultra-fast outflows (UFOs) and large-scale warm absorbers (WAs) are commonly found in the X-ray spectra of many Seyfert galaxies and quasars. Even though a correlation between these two absorbers has been suggested in the past, a direct link is still missing. Here we present the analysis of 12 XMM-Newton EPIC spectra in which, together with WA and UFO, we found a 'low-ionization UFO'. This absorber has the same velocity as the UFO ($v \sim 0.15c$), but ionization and column density comparable with the WA ($\log(\xi/\mathrm{erg\ cm\ s^{-1}}) \sim 0.5$ and $\log(N_H / \mathrm{cm^2}) \sim 21.5$, respectively). Moreover, independently on the assumption of either momentum- or energy-conserving UFO-WA interaction, this absorber shows a low value of the clumpiness, $Cv \sim 10^{-3}$. This strongly suggests that this absorber is produced by the interaction between the UFO on the surrounding WA, and that such interaction occurs via entraining of a fast UFO on the WA, pushing a fraction of clumps to comparable velocities, producing the observed 'entrained ultra-fast outflow' (E-UFO).

ACTIVE GALACTIC NUCLEI / 455

A New Sample of Soft X-ray dominated AGNs

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Ordinary Type 1 AGNs show X-ray spectra dominated by a hard power law sometimes accompanied by soft X-ray excess emission and only a limited number of AGNs are known to show soft X-ray dominated spectra, which are reminiscent of high/soft or very high state of Galactic black holes. We present our selection of soft X-ray dominated AGNs using the XMM-Newton serendip- itous source catalogue. We apply conditions of small hardness ratios, sufficient full band counts, and construct a sample of 12 soft X-ray dominated AGNs, for which detailed X-ray spectral analysis has not published. Nine among them show extremely soft X-ray spectra represented by a power law with a photon index of 3-4. Their spectra are not compatible with ordinary soft excess rep- resented by thermal emission with kT=0.1 - 0.2 keV. Their 2-10 keV luminosities are in the wide range of $2x10^{40}$-$2.5x10^{45}$ erg s^{-1}. We will summarize their X-ray properties and UV to X-ray SEDs.

ACTIVE GALACTIC NUCLEI / 456

Tracing supermassive black hole feedback, from the event horizon up to cluster scales

Author(s): Francesco Tombesi[1]

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Observations performed in the last decades have shown that supermassive black holes (SMBHs) and cosmic structures are not separate elements of the Universe. While galaxies have sizes roughly ten orders of magnitude larger than SMBHs, black holes would not exist without matter feeding them, and cosmic structures would not be the same without feedback from SMBHs. Powerful winds/jets in active galactic nuclei (AGN) may be the basis of this co-evolution. Synergistic observations in the X-rays and other wavebands has been proven to be fundamental to map AGN winds from the event horizon up to galaxy scales, providing a promising avenue to study the multi-phase SMBH feeding and feedback processes. The combination of X-ray, optical/UV, IR, and mm observations of IRAS F11119+3257 allowed us to link the SMBH activity to molecular outflows that may be able to quench star formation. Follow-up studies on other ULIRGs and quasars show very promising results. Moreover, a spatially resolved, spectroscopic analysis of AGN in clusters may allow us to probe the multiphase medium ranging from galactic to up cluster scales. Revolutionary improvements are expected from upcoming X-ray space observatories, such as XARM and Athena, in synergy with other major space- and ground-based facilities, such as JWST, ALMA, E-ELT, SKA.

ACTIVE GALACTIC NUCLEI / 457

The connection of star-forming rates in galaxies with black hole accretion rates of AGNs

Author(s): Olena Torbaniuk[1]

Co-author(s): Maurizio Paolillo [2] ; Giuseppe Longo [2]

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An important problem in extragalactic astronomy concerns the influence of the presence of active nucleus (AGN) on the large-scale processes in the host galaxy and the correlation between the evolution of the host galaxy and the supermassive black hole (SMBH) in its centre. This connection between galaxies and SMBHs is suggested by the observed tight correlation between the evolution of star-formation rates (SFRs) and AGN activity. But the complexity of separation the radiation of the AGNs from that of the host galaxies over a wide range of redshift and in different wavebands remains one of the essential problems in this topic.
The identification of AGNs in large digital sky surveys is further complicated due to the radiation contamination by star-forming regions and other objects in the host galaxy. The solution of this issue requires the adoption of various selection criteria (and their combination) based on the properties of AGN emission in different wavebands, e.g. optically obscured AGNs can be identified only from their radiation in mid-infrared and X-ray bands.
We present the analysis and correlations of AGNs identification methods in X-ray full, soft and hard bands using the data from XMM-Newton Serendipitous Source Catalogue (3XMM-DR8). For determination of the black hole accretion rates and studying of its correlation with SFRs, it was used the values of stellar mass and star-formation rate of the host galaxies of X-ray selected AGNs from the 8th Data Release of Sloan Digital Sky Survey (SDSS DR8) performed by MPA-JHU group (galSpec catalogue).

ACTIVE GALACTIC NUCLEI / 458

The evolution of XLF of Brightest Cluster Galaxies

Author(s): Paolo Tozzi[1]

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We present a systematic study of the nuclear X-ray
luminosity function (XLF) of Brightest Cluster Galaxies (BCGs) for a wide range of halo masses, exploiting the entire Chandra archive (~600 BCGs). Thanks to the ~1 arcsec angular resolution, we are able to trace their radiatively-efficient nuclear activity through cosmic epochs from z=0.1 to z~>1, and to investigate the properties of the surrounding ICM. This work complements the easurement or radio emission of BCGs in the studies of feedback mechanisms across cosmic epochs in massive galaxy clusters, showing an increase in the feedback intensity with redshift, and, possibly, a switch in the feedback mode from mechanical to radiative. Our final goal is to constrain the cycle of hot and cold baryons in the core of groups and clusters of galaxies, including the origin of the feeding gas, the accretion regime, and the effects of feedback onto the surrounding ICM and on the star formation in the BCGs.

ACTIVE GALACTIC NUCLEI / 459

The serendipitous source catalogue from overlapping XMM-Newton observations

Author(s): Iris Traulsen[1]

Co-author(s): Axel Schwope [1]; Georg Lamer [1]; on behalf of the XMM-Newton Survey Science Centre Consortium

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20 years after its launch, XMM-Newton has performed more than 13,000 pointed observations which cover a total of more than 1,100 square degrees. The XMM-Newton Survey Science Centre consortium (SSC) generates serendipitous source catalogues from all public observations, which list positions and source parameters such as position, fluxes, hardness ratios, and extent. In 2018, we have published for the first time a catalogue from simultaneous source detection in a selection of 1,789 overlapping observations. It is based on a new standardised procedure for multiply observed sky areas and includes almost 72,000 sources. In addition to the standard parameters, it provides information on their inter-observation variability, derived directly from the simultaneous fit. The longer effective exposure time and the combined fit result in more faint detections, more precise determination of the source parameters, and likely lower spurious source content than for single observations.
This year, celebrating the anniversary, the SSC compiles new, fully reprocessed source catalogues. The next catalogue of sources in repeatedly observed sky areas is made from 1,340 stacks comprising about 7,500 individual observations with reasonably low background. Its sources are observed up to 65 times with a cumulated exposure time of about 1ks up to 2Ms.

ACTIVE GALACTIC NUCLEI / 460

X-ray imaging of relativistic shock in hotspots of Pictor A radio galaxy

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Co-author(s): Ł. Stawarz ; V. Marchenko ; K. Balasubramaniam ; U. Pajdosz

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Here we present some preliminary results of our analysis of the Chandra observations of the Western and Eastern hotspots in the Pictor A radio galaxy. All the available Chandra data for the target, consisting of multiple pointings spanning over 15 years and amounting to the total exposure time of 464ks, have been included in the analysis. In particular, with the image deconvolution method we studied the X-ray morphology and variability in the Western hotspot region, confirming the flux changes taking place in the source on the timescale of years, and clearly resolving the bow-shock structure of the hotspot. For the Eastern hotspot, we performed a detailed spectral analysis of various regions selected based on the observed correlation between the X-ray intensity and the polarised radio intensity. All in all, our findings suggests a substantial sub- structure of the targeted relativistic shocks, and this has profound consequences for understanding acceleration of high-energy particles at relativistic shocks, as well as the pressure balance between magnetic field and ultra-relativistic electrons within the extended lobes of radio galaxies.

ACTIVE GALACTIC NUCLEI / 461

Restarting activity in hard X-ray selected giant radio galaxies

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Giant radio galaxies (GRGs) are the largest (size >0.7 Mpc) and most energetic single objects in the Universe and represent an extreme class among radio-loud/jetted active galactic nuclei. Such large and old sources are ideal targets to study the duty cycle of the jet and nuclear activity. Here we discuss the X-ray and radio properties of a complete subsample of 15 GRGs; the sources were extracted from a parent sample of ~70 radio galaxies selected, for the first time, in the hard X-ray band from the INTEGRAL and Swift/BAT catalogues (Bassani et al. 2016). We find a correlation between the X-ray luminosity and the radio core luminosity consistent with the so-called fundamental plane of black hole activity, while the radio luminosity of the radio lobes is a factor of 10 weaker than expected from the nuclear luminosity (Ursini et al. 2018). We also find that, despite their old age, a large (~60%) fraction of objects host a young, gigahertz-peaked spectrum radio core (Bruni et al. 2019). Moreover, several objects show a peculiar radio morphology, such as double-double or X-shaped, indicative of a restarted activity. All in all, the X-ray and radio properties suggest an evolution driven by multiple activity phases of the central engine. Finally, we discuss the hard X-ray GRGs as multi-messenger sources of cosmic rays, gamma rays and neutrinos.

ACTIVE GALACTIC NUCLEI / 462

The X-ray variability of LLAGN NGC 5273

Author(s): Federico Vincentelli[1] ; Ian Mc Hardy[1] ; Mayuk Pahari[1]

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In this talk I present the first results regarding the X-ray variability of the nearby Low luminsity AGN NGC 5273. The source was observed with a 90 ks pointing by XMM in 2017 and was found to be significantly variable down to timescales of 1000 seconds. From the Fourier analysis it was possible to detect for the fist time the presence of reverberation lag at the iron K line of ~700 seconds. More interestingly, from the spectral analysis it was found that the source decreased it's flux of a factot of ~5 in just 3 years without showing variations in the amount of absorption. I will then pass to show all archival observations, showing how this source change significantly both it's X-ray and radio luminsity in the last 20 years.

ACTIVE GALACTIC NUCLEI / 463

Photoionisation Modelling of the Emission Line Regions in the Nucleus of NGC 7469

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The Seyfert 1 galaxy NGC 7469 was the target of an extensive observing campaign with XMM-Newton in 2015. Analysis of the 640 ks RGS spectrum with the spectral fitting code SPEX, and the physically self-consistent photoionisation model PION, shows that the emission line region (ELR) is multi-phased, while also accounting for three warm absorber (WA) components. For the first time we characterise the emission features in the RGS spectrum in detail and derive estimates for the distances of the ELR from the central engine. These are ~2.5 pc for the two narrow line components if we adopt an extended emission region and assume a volume filling factor of 0.1, making the ELR to be further out from the nuclear black hole than the WA. We discuss how adjusting the volume filling factor could resolve the differences with distance estimates obtained from variability arguments. Comparisons with other AGN, such as NGC 5548 and NGC 3783, for which we have also computed distances, will be presented.

ACTIVE GALACTIC NUCLEI / 464

Exploring the Diversity of Type 1 Active Galactic Nuclei Identified in SDSS-IV/SPIDERS

Author(s): Julien Wolf[1] ; Mara Salvato[2] ; Damien Coffey[3] ; Andrea Merloni[1] ; Riccardo Arcodia[4] ; Dalya Baron[5] ; Johannes Buchner[1] ; Francisco J Carrera[6] ; Johan Comparat[7] ; Donald P. Schneider[8] ; Kirpal Nandra[2]

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We present a statistical analysis of the optical properties of an X-ray selected Type 1 AGN sample using high signal-to-noise ratio (S/N>20) spectra of the counterparts of the ROSAT/2RX sources in the footprint of the SDSS-IV/SPIDERS (Spectroscopic IDentification of eROSITA Sources) programme. The sample of 2100 source is a factor of 4-18 larger than samples used in previous studies of this type. It significantly extends the probed redshift and luminosity ranges ($z \sim 0.01 - 0.80$ and $L_{0.1-2.4\ kev}$ $1.9\times10^{41}-9.9\times10^{45}$erg/s).
By means of a Principal Component Analysis, we derive Eigenvector (EV) 1 and 2 in an eleven dimensional optical and X-ray parameter space. The validity of the correlations of the Eddington ratio L/L_{Edd} with EV1 and the black hole mass with EV2 are strongly confirmed up to the redshift and luminosity ranges probed in this work.
Investigating the asymmetry of the broad Hβ lines, we show that the redshift of a very broad component, possibly stemming from the Very Broad Line Region, is a strong marker of diversity in our sample.
Furthermore, we report an intriguing difference in the relation between the equivalent width of the FeII emission and the continuum emission for the red- and blue-asymmetric Hβ emitting populations, and show that this contrasting behaviour is consistent with a flattened, stratified model of the Broad Line Region, in which the FeII emitting region is shielded from the central source.

ACTIVE GALACTIC NUCLEI / 465

Revealing the Compton-thick Active Galactic Nuclei in the Two "Non-merging" Luminous Infrared Galaxies with Broadband X-ray Observations (NGC 5135 and UGC2608)

Author(s): Satoshi Yamada[1]

Co-author(s): Yoshihiro Ueda [1] ; Saeko Oda [1] ; Atsushi Tanimoto [1]

[1] *Kyoto University*

Recent X-ray studies suggest that mergers play an important role for obscuration of active galactic nuclei (AGNs) in ultra/luminous infrared galaxies (U/LIRGs). Here we analyze the broadband X-ray spectra (0.5-50 keV) of two "non-merging" LIRGs (NGC 5135 and UGC 2608) utilizing the data of NuSTAR, Suzaku, XMM-Newton, and Chandra, in order to search for differences in the torus structure from "merging" U/LIRGs. Applying the X-ray clumpy torus model (XCLUMPY: Tanimoto et al. 2019), we find that both sources show similar spectra characterized by heavily absorption with $N_H > 1 \times 10^{24}$ cm^{-2}, and the torus angular-width is <30 degrees, respectively. The luminosity ratio between the [O IV] 25.89 μm line and 12 μm continuum is consistent with those of typical Seyfert galaxies, also suggesting that the covering fractions of the tori are moderate (Yamada et al. 2019). Our result implies that AGNs in non-merging galaxies tend to be not deeply "buried", in contrast with U/LIRGs in late merging stages.

ACTIVE GALACTIC NUCLEI / 466

Studying circumnuclear matter in Compton-thick AGN via spectroscopy and future X-ray polarimetry

Author(s): Alessandra Zaino[1]

Co-author(s): Stefano Bianchi [2]; Andrea Marinucci [3]; Giorgio Matt [3]

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[3] *Università Roma Tre*

The archetypal and one of the brightest Compton-thick AGN is NGC 1068, which was observed by all the main X-ray observatories during the last 20 years. Keeping in mind the previous studies, I will discuss the results obtained through the spectroscopic analysis of the latest NuSTAR monitoring campaign, during which we detected one unveiling and one eclipsing event due to Compton-thick matter supposedly located in the innermost part of the torus or even more inside, thus providing further evidence of the clumpy structure of the circumnuclear matter in this source. Furthermore, I will discuss what we can infer on the geometry of NGC 1068 and other Compton-thick AGN with the advent of future X-ray polarimetry missions, such as the X-ray Polarimetry Explorer (IXPE), due to be launched in April 2021.

ACTIVE GALACTIC NUCLEI / 467

Constraining the size of the corona with fully relativistic calculations of spectra of extended corona

Author(s): Wenda Zhang[1]

Co-author(s): Michal Dovciak [1]; Michal Bursa [1]

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The size and geometry of the X-ray emitting corona in AGNs are still not well constrained. Dovčiak & Done (2016) proposed a method based on calculations assuming a point-like lamp-post corona. To perform more self-consistent calculations of energy spectra of extended coronae, we develop monk, a Monte Carlo radiative transfer code dedicated to calculations of Comptonised spectra in the Kerr spacetime. In monk we assume Klein-Nishina scattering cross section and include all general relativistic effects. We find that for a corona located above the disc, the spectrum is not isotropic, but with harder and less luminous spectra towards observers at lower inclinations, owing to anisotropic illumination of the seed photons. This anisotropy also leads to an underestimated size of the corona if we assume the corona to be a point-like, isotropic source located on the black hole rotation axis, demonstrating the necessity of more self-consistent calculations. We also inspect the effect of motion and geometry of the corona on the emergent spectrum. Finally, we will discuss the implication of anisotropic corona emission for the reflection spectrum in AGNs as well as black hole X-ray binaries (BHXRBs).

ACTIVE GALACTIC NUCLEI / 468

A sample of AGNs with known inclination angle

Author(s): Xiurui Zhao[1] ; Stefano Marchesi[1] ; Marco Ajello[1]

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The cosmic X-ray background (CXB), the diffuse X-ray emission observed between 0.5 keV and 300 keV, is thought to be mainly produced by obscured and unobscured active galactic nuclei (AGNs). According to the historical AGN unified model, different types of AGNs are obscured by a structure of gas and dust named torus but with different inclination angle. With the successful launch of the high-resolution X-ray observatories in recent decades, more and more physically motivated models with different assumptions were developed to study these excellent spectra of AGNs. Nevertheless, the physical and geometrical properties of the obscuring torus are still quite unclear, due to the complexity of the models and the limited number of the sources with high-quality X-ray spectra. In this presentation, I will introduce the results of a sample of AGNs with high-quality data of NuSTAR, XMM-Newton and Chandra. All the sources in the sample have foreknown inclination angle measured in optical, which could give better constraints on the information of the obscuring torus, especially the geometrical properties of the torus.

ACTIVE GALACTIC NUCLEI / 469

Testing General Relativity with X-ray Reflection Spectroscopy of Black Holes.

Author(s): Ashutosh Tripathi[1]

[1] *Fudan University*

Einstein's theory of general relativity has been extensively tested in the weak field limit, with experiments in Solar System and observations of binary pulsars. On the contrary, the strong field regime is still largely unexplored. Recently, we have developed a model that can test strong gravity with X-ray reflection spectroscopy of black hole systems. In this talk, I will introduce RELXILL_NK, which is the first XSPEC reflection model to perform tests of general relativity by testing the Kerr black hole hypothesis. I will also present the constraints obtained by analyzing 350 ks simultaneous XMM-Newton and NuSTAR observations of the Narrow-line Seyfert galaxy MCG-06-30-15.

ACTIVE GALACTIC NUCLEI / 470

X-rays from the youngest extragalactic radio jets

Author(s): Malgosia Sobolewska[1]

[1] *CfA*

Formation and launching of relativistic jets is one manifestation of black hole activity. Jets impact the black hole surrounding and thus affect further black hole feeding and growth. This coupling is believed to be essential to the idea of AGN-galaxy feedback. Theory predicted that young radio jets should be strong high-energy emitters. However, they proved to be relatively faint and observing them has been challenging before the Chandra and XMM-Newton era. Here, we discuss the most recent results for a sample of Compact Symmetric Objects (CSO; radio structure sizes < 1 kpc) based on the new high quality spectral energy distributions including XMM-Newton, Chandra, NuSTAR and Fermi/LAT data. For the first time, we have now means to test theoretical scenarios for the high energy emission of the young radio jets (radio lobes origin, shocked ISM, jet, disk corona). We were able to refute the radio lobes origin in at least one source. In addition, we find evidence to support the dichotomy of the CSO environment that we have recently discovered. This dichotomy may suggest that X-ray obscured CSOs have smaller radio sizes than X-ray unobscured CSOs with the same radio power. Thus, the environment may play a crucial role in regulating the early growth of the radio jets. Importantly, X-rays emitted by the X-ray absorbed CSO sub-population, in conjunction with the recent developments in the optical/IR and radio bands, offer new insights for understanding the structure and size of the AGN obscuring torus, as they provide information about the radiative processes and environment on the torus (parsec) scale. We discuss the implications of our results for the earliest stages of a radio galaxy evolution, high energy emission models of radio jets, diversity of the medium in which the jets expand, and jet-galaxy co-evolution.

FUTURE MISSIONS

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Riccardo Giacconi: X-ray Pioneer: Explorer of the Secrets of the Hoary Deep

Author(s): William Forman [1] ; Christine Jones [2]

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We summarize the contributions of Riccardo Giacconi starting from UHURU, through deep survey studies with the Einstein and ROSAT Observatories, to his exploration of the Chandra Deep Field South. In his earliest research with UHURU, Giacconi focussed on Galactic X-ray astronomy with studies of binary X-ray sources, especially Centaurus X-3 and Hercules X-1. With the dramatic increase in sensitivity provided by the Einstein Observatory, he probed the origin of the X-ray background which he continued with ROSAT and his collaborators at MPE. His X-ray studies culminated with the selection and imaging of the Chandra Deep Field South to resolve a large fraction of the X-ray background. We mention his unique contributions across the electromagnetic spectrum with his research and leadership including X-rays (UHURU, Einstein), optical (STScI, ESO), and radio (AUI/NRAO).

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X-ray Imaging Polarimetry with a 2.5 um Pixel CMOS Sensor for Visible Light at Room Temperature

Author(s): Kazunori Asakura [1]

Co-author(s): Hirofumi Noda [1] ; Hironori Matsumoto [1] ; Hiroshi Nakajima [2] ; Hiroshi Tsunemi [1] ; Hisamitsu Awaki [3] ; Kiyoshi Hayashida [1] ; Koki Okazaki [1] ; Shuntaro Ide [1] ; Takashi Hanasaka [1] ; Tomokage Yoneyama [1]

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[3] *Ehime University*

We demonstrate that a CMOS pixel sensor with a pixel size of 2.5 μm can work as a photo-electron tracking X-ray polarimeter. Although it is designed for visible light by GPixel Inc., we succeed in detecting X-ray photons with an energy resolution of 176 eV @5.9 keV (FWHM) at room temper- ature. This performance is remarkable considering that conventional X-ray CCD detectors need to be cooled down to −100°C to detect X-rays in the photon counting mode. We irradiate a polarized X-ray beam to this CMOS sensor with various rotation angles in SPring-8, the synchrotron radia- tion facility in Japan, to evaluate its polarimetry sensitivity. Modulation factors obtained from the number ratio of the double pixel events with different split directions are 7.63 ± 0.07% and 15.5 ± 0.4% at 12.4 keV and 24.8keV, respectively. These results show this CMOS sensor can measure X-ray polarization with the highest spatial resolution ever. We discuss possible applica- tions for future missions of this type of sensors.

FUTURE MISSIONS / 503

Calibrating ESA's Athena mission

Author(s): Jos de Bruijne [1]; Michael Freyberg [2]; Francois Pajot [3]; Giovanni Pareschi [4]; Arne Rau [2]; Richard Willingale [5]

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ESA's Athena mission is due for launch in the early 2030's. The calibration of its optics and instruments is, nevertheless, already subject of several studies and plans. This poster summarises the current calibration baseline of the telescope, the X-IFU micro-calorimeter, and the Wide-Field Imager.

FUTURE MISSIONS / 504

Blazar under the lens of future X-ray polarimeters: perspectives for the IXPE mission

Author(s): Laura Di Gesu [1]

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With the advent of the IXPE (Imaging X-ray Polarimetry Explorer) satellite expected for launch in 2021, the study of the X-ray polarization properties of several bright nearby sources will become possible. Blazars are obvious candidates for X-ray polarization observations. For instance, a high degree of X-ray polarization is expected from high-peaked blazars (HBL) because synchrotron radiation in an ordered magnetic field is naturally polarized. Moreover, X-ray polarization observations have the potential of discriminating between different scenarios for the origin of the X-ray emission in low peaked blazars (LBL) objects. In this talk, we discuss the perspectives of IXPE observations of blazars, focusing on what we can learn about jets.

FUTURE MISSIONS / 505

X-ray polarimetry of extended sources with IXPE

Author(s): Riccardo Ferrazzoli[1]

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The launch of the NASA/ASI Imaging X-ray Polarimetry Explorer (IXPE) mission in Spring 2021 will open a new era of X-ray polarimetry, thanks to the imaging and polarimetric capabilities of the Gas Pixel Detectors.

The unique combination of imaging and polarimetric capabilities over the wide Field of View (8 arcmin) will allow IXPE to investigate the polarimetric properties of complex fields and extended sources. These targets will be studied by means of position- and energy-dependent polarization maps that will clarify the emission processes and the role of the magnetic field structure on the cceleration process in the X-ray emitting region.

Here I will review the state of the art of the expected IXPE performance for the study of extended sources, discussing the results of simulations of the observation of representative targets such as the relativistic Jet of Centaurus A, the Tycho Supernova remnant and the Molecular Clouds in the Galactic center.

FUTURE MISSIONS / 506

XMM-Newton mission operations - preparing for the third decade

Author(s): Marcus Kirsch[1]

Co-author(s): Timothy Finn[2] ; Nikolai v. Krusenstiern[2] ; Arnfried Magunia[3] ; Jim Martin[1] ; Norbert Pfeil[3] ; David Salt[2] ; Detlef Webert[2] ; Uwe Weissmann[2] ; Liviu Toma[2] ; Ian Benson[4]

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ESA's X-ray flagship the XMM-Newton space observatory is soon entering it's third decade of operations.
Both the spacecraft and the payload are operating without major degradation and scientific demand is continuously very high. Changing the on board Attitude and Orbit Control System Software in 2013 we managed to reduce the fuel consumption by a factor of two, additionally reducing stress on the reaction wheels. Currently the Flight Control team is preparing a new thermal operations strategy of the tank system to ensure that the saved fuel is available for continuous usage.
We will describe the status of implementation of the so called "fuel migration and replenishment" activities and make predictions how to operate the spacecraft with this concept potentially up to 2030+.
Furthermore we describe the overall health status of the mission, the need for evolution of the ground segment and concepts on streamlining mission operations with continued high safety requirements using automation tools to keep the science return at the highest possible levels.

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Polarimetry of GRS 1915+105 in thermal state with the future IXPE mission

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Co-author(s): Jiří Svoboda ; Michal Dovciak [2] ; Niccolo Di Lalla [3]

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[3] *INFN | University of Pisa*

I will summarize our recent results on X-ray polarization simulations for the X-ray binary GRS 1915+105 in thermal state with the aim to assess the capability of the future X-ray polarimetry measurements to put independent constraints on black hole spin and orientation of the system. For this purpose, we simulate X-ray polarimetric properties of GRS 1915+105 for the planned Imaging X-ray Polarimetry Explorer (IXPE) satellite. For the simulations, we employ our recently developed KYNBB code to calculate the Stokes parameters using a multicolor black body emission model accounting for thermal radiation from the disk accretion (Dovčiak et al., 2008). We will present our results of the fitting analysis of the simulated data to show the precision of constraints on black hole spin and orientation for different exposures of the planned observation.

FUTURE MISSIONS / 508

VERT-X: a new calibration facility for the ATHENA mirror assembly.

Author(s): Alberto Moretti [1] ; Giovanni Pareschi [2] ; Michela Uslenghi [1] ; Nicola La Palombara [1] ; Bianca Salmaso [1] ; Giorgia Sironi [3] ; Stefano Basso [1] ; Gianpiero Tagliaferri [1] ; Mauro Fiorini [1] ; Daniele Spiga

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Calibration of the ATHENA telescope is a critical aspect of the project and raises significant difficulties due to the unprecedented size, mass and focal length of the mirror assembly. The VERT-X project, financed by ESA and started in January 2019 by a Consortium led by INAF and which includes EIE,Media Lario Technologies, GPAP, and BCV Progetti, aims to design an innovative calibration facility. The VERT-X concept is based on a beam expanded and paralleled by means of an inverted X-ray collimator which covers the entire ATHENA optics through a raster-scan mechanism put at short distance. This machinery allows a vertical and compact design with significant benefits with respect to traditional long-tube traditional facilities.

FUTURE MISSIONS / 509

Accretion and ejection mechanisms in active galactic nuclei: the SKA and Athena synergy

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A rich phenomenology of jets, winds, and accretion states has been observed in both active galactic nuclei (AGN) and X-ray binaries (XRBs), suggesting a connection between the accretion and ejection flows at different black hole masses, from supermassive down to stellar mass. In AGN, the radiation field from the disk and the outflows, both of winds and jets, are thought to play a fundamental role in the feedback invoked in galaxy formation and evolution. Notwithstanding their importance, our knowledge of the accretion and ejection phenomena and their interplay is still very limited. Single-object and population studies can explore the accretion/ejection mechanism in XRBs and AGN. The Athena X-ray observatory will be launched when the complete SKA array will be fully operative. The combination of these two facilities will provide fundamental improvements on several topics, revolutionizing our comprehension of the accretion/ejection phenomena at all scales (spatial, mass, radio power). The Athena-SKA synergy will allow us to disentangle the jet/disk flows based on their different contributions to the overall spectral energy distribution, expected to be different in ADAF, ADAF-jet and standard disk/corona models. The superb SKA and Athena sensitivities will lead to high temporal resolution, allowing to test the coronal emission models where reconnection events produce relativistic electrons, which may produce both the radio and the X-ray emission, leading to correlated variability. Given the large number of AGN that SKA will observe/detect, it will be possible to reconstruct all the AGN accretion phases in the local Universe, from pure ADAF, to ADAF-jet dominated, to accretion efficient regimes.

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Enhancing the ATHENA effective area at low x-ray energies with unconventional overcoatings

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Low density overcoatings (mainly based on materials containing Carbon) onto usual hi Z materials (like Ir, Au or Pt) have been proposed more than 10 years ago for enhancing the X-ray reflectivity at low energy (between 0.5 and 4 keV) in X-ray astronomical optics. The hack is to use the total reflection from the low density material (which do not suffer much the photoelectric absorption) at low energy, while the photons at high energy are reflected by the high density material. Now for several future projects like e.g. ATHENA and eXTP it is foreseen the use of low density overcoatings that will importantly increase the effective area at low energy. In this poster we will discuss about the use of materials different from the ones considered so far, in particular based on a thin layer of Chromium followed by another layer of a Carbon-like material, and of novel approaches for their application.

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X-ray Spectroscopy and Polarimetry of Black Hole X-ray Binaries (BHXBs)

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X-ray Polarimetry will open a new window in X-ray Astronomy that can revolutionize the current understanding of the accretion and ejection mechanisms of black holes X-ray binaries (BHXBs). With the upcoming launch of the Imaging X-ray Polarimetry Explorer (IXPE) in 2021, X-ray astronomy will be benefited with the additional Polarimetry signal along the currently existing timing and spectroscopic analysis. Since BHXBs are highly variable in time, the polarimetry signals might also vary depending upon various intrinsic properties. So, it is necessary to have a thorough spectral and timing analysis of different states of the source. In my PhD work we are performing a spectroscopic analysis of different states of the well known Low Mass X-ray Binary GRS 1915+105 and we will check how the polarimetric signal varies in different states. We have found strong evidence of an accretion disk wind using the Chandra HETGS spectra, and we are modeling it using both Xstar and the MHD as in the case of accretion disk winds in GRO J1655-40 (Fukumura et al 2017). We further simulated the modulation factor and angle as to be seen by IXPE using the ixpeobsim simulator for the different states of GRS 1915+105. We plan to extend the same analysis for other X-ray binaries like Cygnus X-1, Cygnus X-3 etc.

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Astrophysics with the Athena/WFI in the 2030ies

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The Wide Field Imager (WFI) is powerful new spectral-imaging camera for Athena, ESA's next large X-ray observatory to be launched in the early 2030ies. The WFI will provide two defining capabilities to mission, sensitive wide-field imaging spectroscopy over a 40x40 arcmin field of view with an angular resolution of 5" HEW, and the power to observe even the brightest X-ray point sources with very high throughput and low pile-up. In this talk we will present the key science drivers, which include uncovering typical supermassive black hole (SMBH) activity at z>6, into the dark ages where the first stars and galaxies formed; performing a complete and quantified census of black hole activity at z=1-4, including the most obscured objects; pinpointing the hot gas occupying the most massive dark matter haloes at z>2 when the first groups and clusters of galaxies formed; measuring the temperature and abundances of clusters of galaxies out to their virial radius; and performing spectral-timing measurements of bright compact sources to determine the structure of the innermost accreting regions. In addition we will explore further opportunities that will be enabled by the capabilities of the instrument.

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Arcus, The Soft X-ray Grating Explorer

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Arcus will provide high-resolution soft X-ray spectroscopy in the 12-50Å bandpass with sensitivity orders of magnitude higher than any previous astronomical observatory. Its capabilities include spectral resolution >2500 and effective area of ~250 cm^2. The three top science goals for Arcus are to (1) measure the effects of structure formation imprinted upon the hot baryons that are predicted to lie in extended halos around galaxies, groups, and clusters, (2) trace the propagation of outflowing mass, energy, and momentum from the vicinity of the black hole to extragalactic scales as a measure of their feedback and (3) explore how stars, circumstellar disks and exoplanet atmospheres form and evolve. Arcus relies upon the same 12m focal length grazing-incidence silicon pore X-ray optics (SPO) that ESA has developed for the Athena mission; the focal length is achieved on orbit via an extendable optical bench. The focused X-rays from these optics are diffracted by high-efficiency Critical-Angle Transmission (CAT) gratings, and the results are imaged with flight-proven CCD detectors and electronics. The power and telemetry requirements on the spacecraft are modest and mission operations are straightforward, as most observations will be long, uninterrupted, and pre-planned.

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Integration facility for the ATHENA X-ray telescope

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The optics of ATHENA (Advanced Telescope for High-ENergy Astrophysics) – the next high-energy astrophysical mission of the European Space Agency – consists of 678 Silicon Pore Optics mirror modules integrated and co-aligned onto a common supporting structure. The integration process, already proved, exploits an optical bench to capture the focal plane image of each mirror module when illuminated by an ultra-violet plane wave at 218 nm. Each mirror module focuses the collimated beam onto a CCD camera placed at the 12 m focal position of the ATHENA telescope and the acquired point spread function is processed in real time to calculate the centroid position and intensity parameters. This information is used to guide the robot-assisted alignment sequence of the mirror modules.
To implement the above process to the entire ATHENA optics, a dedicated vertical optical bench is being designed. The facility consists of a paraboloid mirror that collects the light from an ultraviolet point source and generates a single reference plane wave large enough to illuminate the 2.6 m aperture of the X-ray telescope; a 15 m tall tower supports the CCD camera at the focal plane position, where the light from each mirror module is focused. The facility must also allow an alignment accuracy of 1 arcsec for the integration of two mirror modules per day in any arbitrary integration sequence, including the option of removing, re-aligning, or replacing any mirror module.
The detailed design of optical bench and the status of the construction activities will be presented at the conference.

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The Athena Community Office

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The *Athena* Community Office (ACO) was established by ESA's *Athena* Science Study Team (ASST) in order to obtain support in performing its tasks assigned by ESA, and most especially in the ASST role as "focal point for the interests of the broad scientific community". The ACO is led by the Instituto de Física de Cantabria (CSIC-UC). Further ACO contributors are the University of Geneva, MPE and IRAP.

In this poster, we will describe the ACO main responsibilities, which are: assist the ASST in organising and collecting support from the *Athena* Working Groups and Topical Panels; organise and maintain the documentation generated by the Athena Working Groups and Topical Panels; manage the Working Group and Topical Panel membership lists; assist the ASST in promoting *Athena* science capabilities in the research world, through conferences and workshops; keep a record of all papers and presentations related to *Athena*; support the production of ASST documents; pro- duce and distribute regularly an *Athena* Newsletter, informing the community about all mission and science developments; maintain the Athena Community web portal; maintain an active communication activity; promote, organise and support *Athena* science-related public outreach, in coordination with ESA and other agencies involved when appropriate; and, design, produce materials and provide pointers to available materials produced by other parties.

In summary, ACO is meant to become a focal point to facilitate the scientific exchange between the *Athena* activities and the scientific community at large, and to disseminate the *Athena* science objectives to the general public.

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Review of the particle background of the Athena X-IFU instrument

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Athena is the second large-class X-ray mission of the European Space Agency Cosmic Vision with a launch foreseen in 2031 towards an L2 halo orbit and dedicated to the study of the hot and energetic universe. X-ray observations are usually severely limited by the background, due to the intrinsic faintness of the astrophysical sources involved or to their diffuse nature. Here we are going to address the particle-induced background of the X-IFU instrument. Above 2-3 keV the background is dominated by two populations of the charged particles: low energy particles that are funneled by the mirrors into the focal plane, and the high energy particles, that possess enough energy to travel trough the spacecraft and reach the detector from any direction.